

# Individual and organisational determinants of use of ergonomic devices in healthcare

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## ABSTRACT

**Objective** This study aims to identify individual and organisational determinants associated with the use of ergonomic devices during patient handling activities.

**Methods** This cross-sectional study was carried out in 19 nursing homes and 19 hospitals. The use of ergonomic devices was assessed through real-time observations in the workplace. Individual barriers to ergonomic device use were identified by structured interviews with nurses and organisational barriers were identified using questionnaires completed by supervisors and managers. Multivariate logistic analysis with generalised estimating equations for repeated measurement was used to estimate determinants of ergonomic device use.

**Results** 247 nurses performed 670 patient handling activities that required the use of an ergonomic device. Ergonomic devices were used 68% of the times they were deemed necessary in nursing homes and 59% in hospitals. Determinants of lifting device use were nurses' motivation (OR 1.96), the presence of back complaints in the past 12 months (OR 1.77) and the inclusion in care protocols of strict guidance on the required use of ergonomic devices (OR 2.49). The organisational factors convenience and easily accessible, management support and supportive management climate were associated with these determinants. No associations were found with other ergonomic devices.

**Conclusions** The use of lifting devices was higher in nursing homes than in hospitals. Individual and organisational factors seem to play a substantial role in the successful implementation of lifting devices in healthcare.

## INTRODUCTION

Low back pain is the most common musculoskeletal disorder among nurses.<sup>1–6</sup> A significant proportion of back pain episodes can be attributed to events that occur during patient handling activities. Nurses are exposed to lifting, awkward working postures, and pushing or pulling during patient handling activities. These activities have been reported to be an important cause of back complaints.<sup>5 7–9</sup>

In the past number of years many ergonomic interventions have been developed to reduce exposure to physical load related to patient handling activities in order to (partly) reduce the occurrence of back complaints. The efficacy of ergonomic devices designed to reduce exposure to physical load has been assessed in a number of laboratory studies.<sup>10–13</sup> However, the implementation of these ergonomic devices in the actual work situation remains difficult, and workplace studies have

## What this paper adds

- ▶ This is one of the first studies to describe and quantitatively evaluate barriers to appropriate implementation of primary prevention interventions.
- ▶ This study demonstrates that the actual use of lifting devices by nursing staff was strongly associated with nurses' motivation to use these devices, prior experience of back complaints in the past 12 months among nurses, and the availability of patient specific protocols with strict guidelines for staff use of ergonomic devices.
- ▶ The results indicate that workplace policies should target these individual and organisational factors when implementing healthcare interventions that include lifting devices to help reduce physical load during patient handling activities.

difficulties showing the effectiveness of ergonomic devices as regards the occurrence of back complaints.<sup>14</sup> An important step in the implementation process is the identification of obstacles to changing work practices, which may arise at the level of individuals as well as the wider environment.<sup>15</sup> In the review of Koppelaar *et al*, five studies identified individual factors, such as lack of perceived need and lack of knowledge, and nine studies identified organisational factors, such as lack of time, lack of a policy of mandatory lift usage and employee-to-ergonomic device ratio, which may hamper the effective implementation of ergonomic devices in the workplace.<sup>16</sup> Although many barriers have been identified in intervention studies, none of the intervention studies assessed the influence of these barriers on the actual use of the ergonomic devices.<sup>16</sup>

Therefore, the aim of this study was to evaluate the influence of individual and organisational determinants on the actual use of ergonomic devices during patient handling activities in healthcare.

## Method

### Study population

This cross-sectional study took place in 19 nursing homes and 19 hospitals in the Netherlands. Organisations with a structured patient handling programme including the presence of ergocoaches were included. An ergocoach (also called a peer leader, lifting coordinator, back injury resource nurse, lifting specialist and mobility coach) is a person trained and specialised in ergonomic



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principles who works in a ward like any other nurse. An ergo-coach is responsible for starting and maintaining the process of working according to ergonomic principles by being available for questions from colleagues, identifying problems with and conducting assessments of physical load, contributing to workplace improvements, and training personnel.<sup>17</sup> Nursing homes and hospitals were contacted and 46% and 45%, respectively, agreed to participate. Primary reasons for non-participation were lack of time, merger of the facility, and construction work in the facility. Participating and non-participating facilities did not differ as regards location (city versus village); however, no additional information was collected about non-participating facilities. Informed consent was obtained verbally from all nursing homes and hospitals prior to the study.

In the Netherlands, there are two types of nursing homes. First, there are those for long term care of the elderly who are not able to live independently (n=10). These provide general support and uncomplicated nursing care for those with physical, psychogeriatric or psychosocial problems as a result of old age. The other type of home looks after those who need specific nursing care, residential care or rehabilitation as a result of disease, disorder or old age but no longer need specialised medical care in a hospital (n=9). This study also took place in general hospitals in wards with a patient population staying at least a couple of days.

Data collection was carried out between 2007 and 2009 among nurses as well as organisations. Individual nurses (professional nurses and nursing assistants) were observed while performing patient handling activities and interviewed afterwards to gather additional information on individual characteristics and barriers to the use of ergonomic devices during patient handling activities. At the organisational level, information on ward characteristics and ward policies was collected by means of a self-administered questionnaire completed by the team leader on the ward and the ergo-coach. Managers of the nursing homes and the hospitals were asked about organisational policies in self-administered questionnaires.

### Use of ergonomic devices

Observations in the workplace were carried out to collect information about the type of ergonomic devices used during the different patient handling activities. Real-time observations were conducted to assess patient handling activities in relation to the demands of national practice guidelines developed by the healthcare sector.<sup>17 18</sup> A checklist was used to collect information about the types of ergonomic devices and the necessity for ergonomic devices. The different ergonomic devices assessed during patient handling activities were lifting devices for transferring a patient, an electrically operated adjustable bed and adjustable shower chair for use during personal care, an electrically operated adjustable bed and slide sheet for repositioning a patient in bed, and a compression stocking slide for putting on and taking off anti-embolism stockings.<sup>17</sup> For personal care of patients, use of an adjustable bed and use of an adjustable shower chair were assessed separately because these ergonomic devices were used in different personal care situations. An adjustable bed is used during personal care in bed, such as washing and dressing a patient, and an adjustable shower chair is used for showering a patient in a sitting or semi-sitting position. For repositioning patients in bed, the use of an adjustable bed and the use of a slide sheet were assessed separately since the criteria for use of these ergonomic devices differ. An adjustable bed is used to reduce awkward trunk postures, but can also eliminate the need for a transfer and/or reduce the

power required for a transfer, while a slide sheet is a friction-reducing device aimed to reduce the manual forces required.<sup>18</sup>

The requirement for and actual use of the ergonomic devices were assessed according to national practice guidelines developed by the healthcare sector.<sup>17 18</sup> The criteria for use of specific ergonomic devices during patient handling activities are based on the functional mobility of the patients. Three levels can be distinguished: (1) patients who are able to perform activities by themselves; (2) patients who are able to assist and contribute actively, but unable to perform the activity on their own; and (3) patients who are passive with no or very little contribution to the required movements.<sup>19</sup> For transferring a patient, a lifting device is compulsory for a patient in the second and third categories. Adjustable beds are also compulsory for patients in the second and third categories. Adjustable beds were present in most wards and actual use by the nurse was defined when the height of the adjustable bed was appropriate for the patient handling activity being performed. Adjustable shower chairs are required when a patient in the second or third category is showered in a sitting position. For repositioning patients in bed, an adjustable bed and slide sheet are compulsory for patients in the second and third categories. A compression stocking slide should always be used for putting on and taking off patient anti-embolism stockings, independent of the functional mobility of the patient.<sup>18</sup> For each patient a specific protocol is available stating when an ergonomic device should be used, whereby the patient's functional mobility is linked to the national practice guidelines for use of ergonomic devices in specific situations. In the absence of this information, nurses were asked to provide information about functional mobility to assess the requirement for an ergonomic device relative to the patient's characteristics. During the observations the researcher first collected information on the required use of ergonomic devices and subsequently determined during patient handling activities whether these ergonomic devices were actually used. At the start of the observations nurses were asked to participate in the study. The nurses were observed in real-time during a specific patient handling activity. In total, 670 patient handling activities were observed with a total duration of approximately 54 h.

### Determinants of ergonomic device use

Information on potential determinants of ergonomic device use during patient handling activities was obtained at three levels: organisations, wards and individual nurses. For each organisation information was gathered about the number of wards, number of workers and number of patients. For each ward within the organisation, information was obtained about the number of patients, number of nurses and number of ergo-coaches. The ratios of (full-time equivalent) nurses per ergo-coach and the ratio of (full-time equivalent) nurses per patient were calculated per ward and median values were used as the cut-off. Nurses were interviewed concerning age, back complaints and any musculoskeletal complaints, defined as 'the presence of pain or discomfort in the past 12 months',<sup>20</sup> and planned behaviour with regard to ergonomic device use.

Two interlinked approaches were used to identify individual and organisational determinants of ergonomic device use (table 1) as described in the review by Koppelaar *et al.*<sup>16</sup> The first approach of Rothschild is oriented towards individual factors, whereas the second approach of Shain and Kramer primarily focuses on the organisational context.<sup>21 22</sup> The definition of the different categories and the measurement methods are described in table 1. The individual factor motivation to use lifting devices

**Table 1** Definitions and methods of measurement of individual and organisational determinants according to the models of Rothschild and Shain and Kramer

Determinants	Definition	Source	Measurement
1. Individual determinants (Rothschild <i>et al</i> ) <sup>21</sup>	Motivation: willingness of a nurse to undertake the necessary actions to commit to the intervention	N	1. Attention: do you know the existence of the workplace guidelines for physical load?
		N	2. Understanding: do you know when and which ergonomic device you have to use when lifting or transferring patients?
		N	3. Attitude: do you think it is always necessary to use ergonomic devices when lifting or transferring patients with limited mobility or passive patients?
		N	4. Intention: do you always intend to use ergonomic devices when lifting or transferring patients with limited mobility or passive patients?
		N	5. Changed behaviour: do you always use ergonomic devices when lifting or transferring patients with limited mobility or passive patients?
		N	6. Maintenance of behaviour: does it happen, once in a while, that you do not use ergonomic devices when lifting or transferring patients with limited mobility or passive patients?
2. Environment determinants (Shain and Kramer) <sup>22</sup>	Ability: capability of a nurse to do something that requires specific skills, knowledge and experience	N	Years of work experience
		N	Knowledge of national guidelines
	Convenience and easily accessible: availability of resources to use ergonomic devices	R	Storage location of ergonomic devices (in the room of the patient or elsewhere)
		R	Location of the bathroom (attached to the room of the patient or not)
		R	Ratio of number of ergonomic devices per patient on the ward
	Management support: commitment of employers to the ergonomic devices	M	Amount of money spent on maintenance of ergonomic devices (at least €7000 annually was seen as favourable)
		M	Policy of reserving money for activities or supplies to reduce physical load
		M	Annual training of nurses in the use of ergonomic devices
		T	Policy of regular checking amount of ergonomic devices in proportion to mobility of patients
	Supportive management climate: a work organisation which actively promotes use of ergonomic devices	T	Existence of a policy on the maintenance of ergonomic devices on the ward
		T	Physical load a regular topic in team meetings or not
		E	Amount of time that ergocoaches spent on their ergocoach activities per week (mean number of hours per week)
Interactivity: reinforcement of ergonomic devices by other work practices	E	Amount of time that ergocoaches spent on their ergocoach activities per week (mean number of hours per week)	
	R	Availability of patient specific protocols with strict guidelines for ergonomic device use	

E: self-administered questionnaire of ergocoach; M: self-administered questionnaire of manager; N: structured interview of nurses; R: checklist filled out by researcher; T: self-administered questionnaire of team leader.

or other ergonomic devices was measured according to a planned behaviour model following the six consecutive stages of planned behaviour.<sup>23</sup> These stages of planned behaviour were categorised into three groups: attention through intention, changed behaviour and maintenance of behaviour.

### Data analysis

The influence of individual and organisational determinants (table 1) on the outcome variable actual use of ergonomic devices was analysed using multivariate logistic regression analysis with generalised estimating equations (GEE), suitable for the analysis of repeated measurements. The analyses were performed for each patient handling activity separately: (1) lifting device use during transfer of a patient; (2) adjustable bed or adjustable shower chair use during personal care of patients; (3) slide sheet or adjustable bed use during repositioning of patients in bed; and (4) compression stocking slide use during putting on and taking off anti-embolism stockings. The OR was used as measure of association, and indicates the influence of a determinant on ergonomic device use during patient handling activities. An OR >1 reflects that the determinant is associated with increased use of an ergonomic device.

The following procedure was used to identify determinants of actual use of ergonomic devices during patient handling activities. First, all individual as well as organisational variables were analysed in univariate logistic GEE models. The categories with a p value less than 0.20 were selected for further investigation. Second, for those variables that consisted of a composite score across different items, the single items were also analysed in univariate logistic GEE models and identified for further investigation when the p value was less than 0.20. Third, a multivariate logistic GEE model with individual and organisational

variables as independent variables was constructed by forward selection. Variables with a p value less than 0.10 were retained in the final model.

The association of upstream factors with the individual factor motivation of nurses to use lifting devices as well as the availability of patient specific protocols with strict guidelines for ergonomic device use were analysed with Spearman correlations.

Statistical analyses were performed using Proc Genmod in SAS v 9.2.

### RESULTS

Of the 162 team leaders from nursing homes and hospitals invited to participate in the study, 144 returned the self-administered questionnaire (89% response). Of the 269 ergocoaches invited to participate, 233 returned the self-administered questionnaire (87% response). All managers (n=38) invited to participate returned the self-administered questionnaire (100% response). In total, 343 nurses participated in this study and for 247 nurses data collection on observations of patient handling activities and interviews was complete. Nurses participated anonymously in this study. None of the nurses who were invited to contribute to the study refused to participate. A total of 96 nurses were not included because they performed patient handling activities without needing an ergonomic device or were not interviewed due to lack of time. The 247 nurses performed 670 patient handling activities that required the use of an ergonomic device.

The study population consisted predominantly of women, ranging in age from 16 to 62 years (table 2). The average working experience of the nurses was slightly higher in nursing homes than in hospitals. The 12-month prevalences of back complaints and of any musculoskeletal complaints were 43–45% and

**Table 2** Organisational and ward characteristics of nursing homes and hospitals, and individual characteristics of nurses in these organisations

Characteristics	Nursing homes	Hospitals
Organisation	(n=19)	(n=19)
Number of wards per organisation, median (range)	4 (1–12)	29 (5–111)
Workers (fte) per organisation, median (range)	118 (26–400)	1600 (393–3000)
Patients per organisation, median (range)	126 (68–320)	453 (150–1070)
Ward	(n=66)	(n=96)
Patients per ward, median (range)	30 (12–74)	19 (8–41)
Nurses (fte) per ward, median (range)	14 (4–62)	22 (11–64)
Ratio patient/fte nurses per ward, median (range)	1.7 (0.3–7.8)	1.0 (0.2–2.3)
Ratio fte nurses per peer leader, median (range)	9.7 (2.7–30.0)	13.7 (5.5–64.0)
Individual	(n=132)	(n=211)
Age, years, mean (SD)	37 (13)	33 (12)
Gender, female, %	92%	91%
Working experience (years), median (range)	7 (0–43)	6 (0–40)
Back complaints in the past 12 months, %	43%	45%
Any musculoskeletal complaints in the past 12 months, %	58%	65%

fte, full-time equivalent.

58–65%, respectively. Nursing homes and hospitals differed considerably with respect to number of wards, number of workers and number of patients per ward and per organisation. The ratio of patients per full-time equivalent nurses per ward ranged from 0.3 to 7.8 for nursing homes and from 0.2 to 2.3 for hospitals.

Table 3 describes the prevalence of individual and organisational determinants of ergonomic device use during patient handling activities by healthcare branch. The prevalence of barriers was generally higher in hospitals than in nursing homes. A low amount of time spent on ergocoach activities, an unfavourable ratio of slide sheets per patient, and lifting devices not close to the bed were more prevalent in nursing homes (59%, 62% and 89%, respectively). In hospitals an unfavourable ratio of

adjustable shower chairs per patient, lifting devices not close to the bed, and absence of patient specific protocols with strict guidelines for ergonomic device use were more prevalent (70%, 93% and 96%, respectively).

Table 4 provides descriptive information on 670 observed patient handling activities which required the use of an ergonomic device, performed by 247 nurses. The actual use of ergonomic devices when required during patient handling activities ranged from 0% for adjustable shower chairs in hospitals to 92% for adjustable beds in hospitals. The use of ergonomic devices was similar between nursing homes and hospitals, except for a higher use of lifting devices during the transfer of a patient and of adjustable shower chairs during personal care of patients in nursing homes.

**Table 3** Occurrence of individual and organisational barriers to ergonomic device use during patient handling activities in nursing homes and hospitals

Type	Category	Source	Barriers	Nursing homes	Hospitals	
Individual	Motivation	N	Actual behaviour to use lifting devices	Attention through intention	8%	36%
			Changed behaviour	29%	36%	
	Maintenance of behaviour		63%	27%		
	Ability	N	Actual behaviour to use other ergonomic devices	Attention through intention	17%	45%
			Changed behaviour	31%	29%	
			Maintenance of behaviour	52%	24%	
Organisational	Convenience and easily accessible	R	Low work experience	48%	51%	
			Lack of knowledge of workplace guidelines	2%	7%	
	Management support	M	Unfavourable ratio of lifting devices per patient	44%	67%	
			Unfavourable ratio of slide sheets per patient	62%	40%	
			Unfavourable ratio of adjustable shower chairs per patient	21%	70%	
			Lifting devices not close to bed	89%	93%	
			Other ergonomic devices not close to bed	13%	38%	
			Bathroom not attached to patient's room	39%	35%	
	Supportive management climate	T	Management spending little money to maintain ergonomic devices	10%	53%	
			Management not reserving any money for activities or supplies to reduce physical load	40%	51%	
			Nurses not trained in use of ergonomic devices each year	14%	20%	
			No regular checking of amount of ergonomic devices in proportion to mobility of patients	5%	22%	
Interactivity	E	No policy on maintenance of ergonomic devices	6%	18%		
		Physical load not a regular topic in team meetings	27%	65%		
		Little time spending on peer leader activities per week	59%	68%		
		R	Absence of patient specific protocols with strict guidelines for ergonomic device use	35%	96%	

E: self-administered questionnaire of ergocoach; M: self-administered questionnaire of manager; N: structured interview of nurses; R: checklist filled out by researcher; T: self-administered questionnaire of team leader.

**Table 4** Characteristics of the observed patient handling activities requiring use of an ergonomic device and actual ergonomic device use in nursing homes and hospitals

	Devices	Nursing homes (n=19)			Hospitals (n=19)		
		N	n	Device used	N	n	Device used
Transfer	Lifting devices	101	145	105 (72%)	71	80	34 (43%)
Personal care of patients (A)	Adjustable bed	62	81	73 (90%)	82	86	79 (92%)
Personal care of patients (B)	Adjustable shower chair	26	28	15 (54%)	3	3	0 (0%)
Repositioning patients in bed (A)	Slide sheet	68	88	13 (15%)	107	119	14 (12%)
Repositioning patients in bed (B)	Adjustable bed	68	88	75 (85%)	107	119	101 (85%)
Putting on and taking off anti-embolism stockings	Compression stocking slide	20	28	16 (57%)	12	12	5 (42%)
Total		110	370	253 (68%)	137	300	176 (59%)

N, number of nurses; n, number of observations where use of an ergonomic device was required according to workplace guidelines.

Table 5 shows that the individual factors being motivated to use lifting devices and having had back complaints in the past 12 months were important factors for increased lifting device use during patient transfer with ORs of 1.96 and 1.77, respectively. The availability of patient specific protocols with strict guidelines for ergonomic device use had an OR of 2.49. No associations were found between individual and organisational determinants and the use of an adjustable bed or an adjustable shower chair during the personal care of patients, the use of a sliding sheet or an adjustable bed during repositioning of patients in bed, or the use of a compression stocking slide when putting on and taking off anti-embolism stockings.

## DISCUSSION

This study shows that ergonomic devices were actually used 68% of times they were required in nursing homes and 59% in hospitals. Lifting device use during transfer of a patient was strongly associated with motivation among nurses to use lifting devices and experienced back complaints in the past 12 months, as well as the availability of patient specific protocols with strict guidelines for ergonomic device use.

There are a few limitations that must be taken into account in this study. First of all, the cross-sectional design did not permit determination of the direction of associations between the

studied factors and device use. Second, selection might have occurred since participation of nursing homes and hospitals was on a voluntary basis and targeted those that employed ergo-coaches on wards.<sup>24</sup> These organisations may have been more focussed on preventing high physical load.<sup>25</sup> The actual use of ergonomic devices in this study may, therefore, be higher than in a random sample of nursing homes and hospitals. However, information from national surveys in 2008 showed that 85% of nursing homes have employed ergo-coaches on wards.<sup>26</sup> Information from national surveys among hospitals in 2005 showed that ergo-coaches were present in 56% of the hospitals, having increased from less than 10% in 2001.<sup>17</sup> This suggests that the results of this study correctly reflect the situation in Dutch nursing homes and hospitals. Third, since only Dutch healthcare organisations with a structured patient handling programme including the presence of ergo-coaches were included in this study, some caution is needed as regards the generalisability of the study results to other countries. Fourth, nurses may have provided socially desirable answers to questions during the short interview. It is, therefore, possible that the proportion of nurses motivated to use ergonomic devices during patient handling activities is overestimated. Nurses were, however, not aware of the fact that the actual use of ergonomic devices was assessed during the real-time observations. During the short interview

**Table 5** Associations between individual and organisational factors and the use of lifting devices during the transfer of a patient in nursing homes and hospitals

	Lifting device use during patient transfer			
	Univariate		Multivariate (N=238)	
	OR	95% CI	OR	95% CI
<b>Individual factors</b>				
Motivation: changed or maintenance of behaviour to use lifting devices	2.37†	1.20 to 4.67	1.96†	1.00 to 3.86
<b>Ability</b>				
Work experience	0.63	0.36 to 1.12	—	
Knowledge of national guidelines	0.64	0.12 to 3.36	—	
Back complaints in the past 12 months	1.52	0.85 to 2.72	1.77*	0.99 to 3.22
Any musculoskeletal complaints in the past 12 months	1.20	0.67 to 2.14	—	
<b>Organisational factors</b>				
Convenience and easily accessible	0.82	0.39 to 1.71		
Management support	1.34	0.71 to 2.53		
Supportive management climate	2.03*	0.87 to 4.74		
Regular checking of amount of ergonomic devices in proportion to mobility of patients	1.57	0.70 to 3.51	—	
Policy on the maintenance of ergonomic devices	1.30	0.57 to 2.96	—	
Physical load a regular topic in team meetings	1.48	0.80 to 2.73	—	
<b>Interactivity</b>				
Amount of time spent on peer leader activities per week	1.45	0.78 to 2.70	—	
Availability of patient specific protocols with strict guidelines for ergonomic device use	2.67†	1.40 to 5.09	2.49†	1.27 to 4.89

\*p<0.10.

†p<0.05.

N, number of nurses.

afterwards they were asked for their opinion on ergonomic device use. However, it may be that answers on motivation were influenced by actual use. Fifth, the definition of required use was based on the level of functional mobility of the patients. The cognitive capabilities of the patients, as well as their attitudes or preferences towards ergonomic devices, could have influenced the observed actual use of ergonomic devices. In this study, attitude and preferences were not determined. Sixth, in this study the terms ergonomic and lifting devices are used without providing detailed information as to their effects on postural load. It was not evaluated whether these devices were designed appropriately with regard to the intended reduction in postural load. Finally, to determine the necessity of ergonomic devices, the patients were categorised into three levels of functional mobility. The actual use of ergonomic devices could have been influenced by differences in the patients within these three levels.

This study shows that three determinants were strongly associated with lifting device use during the transfer of a patient. First, the motivation of nurses to use lifting devices was strongly associated with increased lifting device use during the transfer of a patient. Several intervention studies have identified lack of motivation as a barrier to the successful implementation of lifting devices in healthcare.<sup>16</sup> Motivation can be influenced by several different factors. In the present study, three organisational factors were moderately associated with motivation of nurses to use lifting devices: a favourable ratio of lifting devices per patient on the ward, lifting devices available close to patients, and management maintenance of ergonomic devices, with Spearman correlations of 0.15, 0.14 and 0.20, respectively. This indicates a managerial influence on nurses adopting the behaviour to use lifting devices when required by making sure that enough lifting devices are available in proportion to patients on the ward, by providing easily available lifting devices, and by ensuring good maintenance. Evanoff *et al* as well as Lynch and Freund have previously reported that the lack of availability of lifting devices was perceived as a barrier to successful implementation of lifting devices in healthcare.<sup>27 28</sup> Ceiling lifts instead of floor lifts might be a solution, since these lifting devices are always in the room of the patient and available for use. Alamgir *et al* reported that staff preferred to use ceiling lifts for transferring and also found them less physically demanding.<sup>29</sup> Moreover, their study showed that transfers performed with ceiling lifts compared to floor lifts required on average less time and were found to be more comfortable for patients.

Second, the availability of patient specific protocols with strict guidelines for ergonomic device use was strongly associated with lifting device use. These protocols that incorporate requirements on safe patient handling into the daily care of patients mean that the way a patient is assisted is no longer largely determined by the individual nurse. A policy of mandatory use of equipment was also reported as facilitate the implementation of lifting devices in healthcare by Evanoff *et al* and Charney *et al*.<sup>27 30</sup> Patient specific protocols with strict guidelines for ergonomic device use were available in 65% of the nursing homes but only 4% of the hospitals in this study. The low percentage in hospitals can be partly explained by rapid improvements in functional mobility in patients who usually stay in hospital for only a few days. In this study four organisational factors were associated with the availability of patient specific protocols with strict guidelines for ergonomic device use: management ensuring ergonomic devices were maintained ( $r=0.21$ ), management reserving money for activities or supplies

to reduce physical load ( $r=0.40$ ), regular checking of the availability of ergonomic devices (in proportion to the mobility of patients ( $r=0.21$ ), and a policy on the maintenance of ergonomic devices ( $r=0.16$ ). This indicates that the commitment of employers to the use of ergonomic devices has a positive influence on the availability of patient specific protocols with strict guidelines for ergonomic device use.

Third, the presence of back complaints in the past 12 months resulted in higher lifting device use among nurses. Apparently, having had back complaints triggers nurses to use lifting devices when required. Lifting devices are, however, intended to prevent both the onset as well as the recurrence of back pain episodes. Thus, nurses without back complaints should be encouraged to use lifting devices when required in order to prevent the onset of these complaints. Although the national practice guidelines advise the use of lifting devices for all nurses, whether or not they have back complaints, compliance with these guidelines is obviously far from optimal.

The use of lifting devices when required was much higher in nursing homes than in hospitals (72% vs 43%). The study by Evanoff *et al* also showed higher compliance in using lifting devices in long term care facilities compared to hospitals (38% vs 15%).<sup>27</sup> Yassi *et al* identified the rapidly changing patient population in hospitals as a barrier to the implementation of lifting devices.<sup>31</sup> Our results, however, indicate that individual and organisational determinants within specific organisations are more important than differences between healthcare branches. In the multivariate analysis, the influence of type of branch on lifting device use disappeared when adjusted for the difference in motivation of the nurses to use lifting devices (63% vs 27%) and the availability of patient specific protocols with strict guidelines for ergonomic device use (65% vs 4%). Also, in hospitals motivation of nurses to use lifting devices and the availability of patient specific protocols with strict guidelines for ergonomic device use influenced required lifting device use, despite the rapidly changing patient population.

For patient handling activities other than transfers, none of the determinants had any association with required ergonomic device use. Other factors, not assessed in this study, may had an influence. With regard to the use of sliding sheets, McGill and Kavcic concluded that the worker's personal technique and movement strategy is a critical determinant of back load in the use of these devices.<sup>11</sup> Pompeii *et al* reported that about a quarter of patient handling injuries resulted from repositioning patients in bed.<sup>32</sup> Thus, training in the use of sliding sheets might help nurses to actually use the sliding sheets in order to prevent the occurrence of back complaints due to repositioning patients in bed. The lack of manoeuvring space, mentioned by Li *et al* and Pompeii *et al* as a barrier to lifting device use, might also be a barrier to shower chair use during personal care.<sup>32 33</sup> Another possible explanation for the lack of association could that our study did not having enough power due less observations of other patient handling activities.

In conclusion, the use of lifting devices was higher in nursing homes than in hospitals. The use of lifting devices when required was strongly associated with motivation among nurses to use lifting devices and experienced back complaints in the past 12 months, as well as the availability of patient specific protocols with strict guidelines for ergonomic device use. This study demonstrated that barriers have a strong effect on the use of lifting devices. Individual and organisational factors seem to have considerable influence on whether ergonomic interventions will indeed contribute to a reduction in physical load in the workplace.

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## REFERENCES

- Lagerstrom M, Hansson T, Hagberg M. Work-related low-back problems in nursing. *Scand J Work Environ Health* 1998;**24**:449–64.
- Smedley J, Egger P, Cooper C, et al. Manual handling activities and risk of low back pain in nurses. *Occup Environ Med* 1995;**52**:160–3.
- Knibbe JJ, Friele RD. Prevalence of back pain and characteristics of the physical workload of community nurses. *Ergonomics* 1996;**39**:186–98.
- Bejia I, Younes M, Jamila HB, et al. Prevalence and factors associated to low back pain among hospital staff. *Joint Bone Spine* 2005;**72**:254–9.
- Ando S, Ono Y, Shimaoka M, et al. Associations of self estimated workloads with musculoskeletal symptoms among hospital nurses. *Occup Environ Med* 2000;**57**:211–16.
- Eriksen W. The prevalence of musculoskeletal pain in Norwegian nurses' aides. *Int Arch Occup Environ Health* 2003;**76**:625–30.
- Garg A, Owen B. Reducing back stress to nursing personnel: an ergonomic intervention in a nursing home. *Ergonomics* 1992;**35**:1353–75.
- Warming S, Precht DH, Suadiciani P, et al. Musculoskeletal complaints among nurses related to patient handling tasks and psychosocial factors - Based on logbook registrations. *Applied ergonomics* 2009;**40**:569–76.
- da Costa BR, Vieira ER. Risk factors for work-related musculoskeletal disorders: a systematic review of recent longitudinal studies. *Am J Ind Med* 2010;**53**(3):285–323.
- Garg A, Owen B, Beller D, et al. A biomechanical and ergonomic evaluation of patient transferring tasks: bed to wheelchair and wheelchair to bed. *Ergonomics* 1991;**34**:289–312.
- McGill SM, Kavcic NS. Transfer of the horizontal patient: the effect of a friction reducing assistive device on low back mechanics. *Ergonomics* 2005;**48**:915–29.
- Silvia CE, Bloswick DS, Lillquist D, et al. An ergonomic comparison between mechanical and manual patient transfer techniques. *Work (Reading, Mass.)* 2002;**19**:19–34.
- Zhuang Z, Stobbe TJ, Hsiao H, et al. Biomechanical evaluation of assistive devices for transferring residents. *Applied ergonomics* 1999;**30**:285–94.
- Hignett S. Intervention strategies to reduce musculoskeletal injuries associated with handling patients: a systematic review. *Occup Environ Med* 2003;**60**:E6.
- Grol R, Grimshaw J. From best evidence to best practice: effective implementation of change in patients' care. *Lancet* 2003;**362**:1225–30.
- Koppelaar E, Knibbe JJ, Miedema HS, et al. Determinants of implementation of primary preventive interventions on patient handling in healthcare: a systematic review. *Occup Environ Med* 2009;**66**:353–60.
- Knibbe HJ, Knibbe NE, Klaassen AJ. Safe patient handling program in critical care using peer leaders: lessons learned in the Netherlands. *Crit Care Nurs Clin North Am* 2007;**19**:205–11.
- Knibbe JJ, Knibbe NE, Geuze L. *Work Practice Guide for Ergonomics in Nursing Homes, Foundations Care and Welfare (in Dutch)*. Utrecht: Foundations Care and Welfare, 2002.
- Knibbe JJ, Friele RD. The use of logs to assess exposure to manual handling of patients, illustrated in an intervention study in home care nursing. *Int J Ind Ergon* 1999;**24**:445–54.
- Kuorinka I, Jonsson B, Kilbom A, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied ergonomics* 1987;**18**:233–7.
- Rothschild ML. Carrots, sticks and promises: a conceptual framework for the management of public health and the social issue behaviours. *J Mark* 1999;**63**:24–37.
- Shain M, Kramer DM. Health promotion in the workplace: framing the concept; reviewing the evidence. *Occup Environ Med* 2004;**61**:643–8, 585.
- Urlings IJ, Nijboer ID, Dul J. A method for changing the attitudes and behaviour of management and employees to stimulate the implementation of ergonomic improvements. *Ergonomics* 1990;**33**:629–37.
- Knibbe JJ, Knibbe NE, Geuze L. *Work instruction 'Better', Foundations Care and Welfare (in Dutch)*. Utrecht: Foundations Care and Welfare, 2003.
- Locomotion. *Questionnaire 'BeleidsSpiegel' Foundations Care and Welfare (in Dutch)*. Bennekom, 2002.
- Knibbe JJ, Knibbe NE. *Fourth National Monitoring of exposure, policy, and back pain in nursing homes 2007 (in Dutch)*. Bennekom: Locomotion, 2008.
- Evanoff B, Wolf L, Aton E, et al. Reduction in injury rates in nursing personnel through introduction of mechanical lifts in the workplace. *Am J Ind Med* 2003;**44**:451–7.
- Lynch RM, Freund A. Short-term efficacy of back injury intervention project for patient care providers at one hospital. *Am Ind Hyg Assoc J* 2000;**61**:290–4.
- Alamgir H, Li OW, Yu S, et al. Evaluation of ceiling lifts: transfer time, patient comfort and staff perceptions. *Injury* 2009;**40**:987–92.
- Charney W, Simmons B, Lary M, et al. Zero lift programs in small rural hospitals in Washington state: reducing back injuries among health care workers. *AAOHN J* 2006;**54**:355–8.
- Yassi A, Cooper JE, Tate RB, et al. A randomized controlled trial to prevent patient lift and transfer injuries of health care workers. *Spine* 2001;**26**:1739–46.
- Pompeii LA, Lipscomb HJ, Schoenfisch AL, et al. Musculoskeletal injuries resulting from patient handling tasks among hospital workers. *Am J Ind Med* 2009;**52**:571–8.
- Li J, Wolf L, Evanoff B. Use of mechanical patient lifts decreased musculoskeletal symptoms and injuries among health care workers. *Inj Prev* 2004;**10**:212–16.

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