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Using shoulder straps decreases heart rate variability and salivary cortisol concentration in Swedish ambulance personnel.

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Abstract

Background.

Previous research has shown that paramedics are exposed to risks in the form of injuries to the musculoskeletal system. In addition there are studies showing that they are over-represented in terms of cardiovascular disease, cancer and psychiatric diseases, partly explained by exposure to stress. The aim of this study is to see if the use the of shoulder straps decreases physical effort in the form of decreased heart rate and cortisol concentration.

Methods.

A stretcher with a dummy was carried by 20 participants 400 metres on two occasions, one with and one without shoulder straps. Heart rate was monitored continuously and cortisol samples were taken at intervals of 0, 15, 30, 45 and 60 minutes. Each participant was her or his own control.

Results.

A significant decrease in heart rate and cortisol concentration were seen when shoulder straps were used. Median for men at 0 minutes 78/21.1 (heart rate/cortisol concentration), 15 minutes 85/16.9 and 60 minutes 76/15.7 and without shoulder straps at 0 minutes 78/21.9, 15 minutes 93/21. 9 and 60 minutes 73/20.5. For women, the results were 85/23.3, 92/20.8, 70/18.4 and 84/32.4, 100/32.5, 75/25.2, respectively.

Conclusion.

The use of shoulder straps decreases measurable physical stress and should therefore be implemented when heavy equipment or a stretcher need to be carried. To ensure this, shoulder straps should be personal or alternatively be sewn into alarm jackets.

Running header

Cortisol and heart rate levels during stretcher carrying.
Key words: ambulance personnel, heart rate, saliva cortisol, shoulder straps, stretcher.

Introduction

About half of all reported occupational injuries in Sweden are related to musculoskeletal strain injury [1]. That medical staffs suffer from various kinds of stress is apparent in The Swedish Social Insurance Agency [2] statistics of sick leave with a length of more than 14 days in 2008. These statistics show that nurses in general have sick leave of 10 days per person/year and other healthcare staff 13 days per person/year. These statistics also include musculoskeletal injuries. Internal figures for the ambulance district investigated show that during the years 2011 – 2013 there was an average of 9 days of sick leave for nurses and 23 for paramedics. The Swedish Work Environment Authority’s Statute Book AFS 2012:2 [3] states that is inappropriate for personnel to lift burdens over 25 kg. It also describes that lifting aids should be used unless the lift can be avoided and that the workplace should be designed so that different kinds of harmful stress are avoided wherever possible. In the ambulance service this is an ambition that can be hard to attain when work has to be done in different environments by two people. The profession requires that sick or injured persons should be cared for indoors or outdoors summer and winter at all hours, in some cases also under time pressure. One other aspect is that the team’s composition varies in different physical conditions, age, height, gender and education. Developments in the ambulance service have gone from carrying patients on stretchers to having stretchers that in most cases are rolled, but the manual lifts of patients remain and heavier equipment has to be carried between the ambulance and place of care [4]. Examples of devices for transferring patients located within the ambulance service are lifting belts, sliding boards, shoulder straps, stair climbers, mattresses for dragging and stretchers. The Swedish ambulance service requires at least one of the team members to be a registered nurse for the administration of drugs. The nurse always has the medical responsibility for the patient. The team may consist of one nurse and one nursing assistant, called paramedics, or two nurses.
There is strong evidence that professional life in general, regardless of profession, involves a high risk of injury in the lower back. Different prevalence rates have been reported, and the estimated annual and long-life risk of suffering from back pain during work varies between 27 to 62.5 % [5-7]. During a lifelong career the stated risk of suffering at some point from back pain related to work is 84-91 % [8, 9]. The major identified risks are heavy lifting [10-12], repetitive or sudden twisting movements [9, 11], stress [10, 12] and deficiencies in the psychosocial environment [13]. Lower back pains are a major occupational hazard, specifically in terms of the ambulance service which reported a 32 - 67% frequency of lower back pain related to work in the past year [14-16]. 10 - 13% of these groups led to shorter or longer sick leave [17, 18]. The reasons mainly follow those of other professions with a predominance of lifting, twisting movements and sudden unexpected movement from the patient. Injuries to the back and upper extremities are not just an emergency event for the individual. The median time per sick leave for lower back pain is five days [19] and it was the most important cause of early retirement, with all that this implies of individual suffering and cost to the society [20, 21].

Although ambulance personnel perceive themselves as healthy [22] there are obvious indications that in addition to neck back pain they are overrepresented for cardiovascular disease, cancer, and psychiatric disorders, conditions in which stress and strain are considered to be an underlying cause [20, 23]. Studies show that proper use of assistive devices and lifting techniques can prevent overload and back problems [24, 25].

Salivary cortisol measurement is a simple and established method and correlates well with cortisol in the blood [26]. The reason for taking cortisol samples in the morning is that cortisol follows a circadian rhythm with higher values after awakening and then rapidly decreasing values [27, 28]. The measurement of heart rate can provide a clinical indicator of stress [29].

**Aim**

Q 1- Study aims;
The aim of this study is to see if the use of shoulder straps reduces physical work, by psychosocial and psychological aspects measuring heart rate and secretion of salivary cortisol before, during and after effort when carrying the stretcher.

Method

Study design and methodology

The study has been conducted in an ambulance organization in southern Sweden. When the study started, this organization consisted of twelve ambulances on duty for 24-hours shifts and eight ambulances on duty only during daytime shifts. The total number of employees was 164.

Requests for participation were sent by postal services and returned by those who agreed to participate. The only exclusion criteria were treatment with any medication that interacts with heart rate and/or cortisol value.

Q4_Typical exposure ranges.

The study was conducted in such a way that pairs of participants carried a standardized stretcher, alfabår™, with a dummy. The total weight, the stretcher (39 kg) and dummy (about 73 kg (160 pound)), was 112 kg. The only previous occasion they used this equipment was in connection with an employment test. Therefore, their previous experience was minimal. The dummy was carried over flat terrain for 400 metres for a duration of about 10 minutes, on two different days. The first time was without and the second time with the shoulder straps of the brand Easylift Shoulder™. The participants changed position after half the distance, the first at the head end and the second at the foot end or the reverse. The same geographical path was used on both occasions. Heart rate was registered by the monitor brand Polar RS 400 from Polar Electro Sweden that logged the heart rate every 15 seconds throughout the time period when collection of saliva cortisol took place. Collections of salivary cortisol were performed with neutral cotton-based Salivette™ tubes just before carrying
the stretcher and 15, 30, 45 and 60 minutes after the first sample. To prevent interference with the results, the participants were informed that they should avoid smoking, taking Swedish snuff, brushing their teeth, drinking coffee and tea in the morning before the test.

**Study period**

All data collection took place between 17 October 2012 and 25 March 2013. Due to physical injury in one participant one last sample was collected on 4 September 2013. The collection of samples started between the hours of 7:46 and 9:23 am. The tests were cancelled in poor weather such as rain or snow in order to ensure as similar conditions as possible. The temperature ranged from plus 15° C to minus 5° C. Data collection took place on work-free days. At least one of the researchers participated as a supervisor on every occasion.

**Participants Q3- Selection – inclusions criteria.**

All 164 employees in the organization were given oral and written information about the study during workplace meetings and all were invited to participate. This group consisted of 99 men and 65 women of whom 129 were nurses and 35 paramedics. The age spans were 31-62 years (mean = 43.4; median = 42) for men and 27-56 years (mean = 40.8; median = 41) for women. 38 employees- 25 males and 13 females- were interested in participating, and of these three were excluded because of medication. Of the remaining 35 employees 21 were randomly selected from a numbered code list by an non-participating people in the study. One woman had to drop out immediately before start because of her own injury. All remaining participants completed the study.

**Demographic data**

Fourteen of the participants were men and six were women. The median ages were 43 (32-53) and 41 (31-44) years old for men and women, respectively. Eleven men were nurses and three were paramedics, and of the women five were nurses and one was a paramedic. The experience of healthcare and prehospital emergency services varied between 7 and 33 years (mean = 17.4) and 4 to
28 years (mean = 11.2) for nurses respectively, compared with 15 to 30 years (mean = 25.5) and 5 and 
29 years (mean = 19.3) for paramedics.

Data collection

All participants were informed about the purpose and structure of the study. Heart rates were 
monitored throughout the time salivary cortisol was collected. The logged heart rate files were saved 
in the Polar Pro Trainer 5™. Salivary cortisol samples were stored frozen at Unilab Skaraborg’s 
Hospital, Skövde and they were later analyzed with a sensitive- validated commercial RIA method, 
Spectria cortisol RIA^{125} coated tubes kits, all at the same point in time. The method has previously been 
described, [30, 31]. Simultaneously with the first test, a study-specific questionnaire with the 
background data was collected.

Data Processing

All tests could be implemented and analyzed for heart rate while 2 cortisol samples could not be 
analyzed due to insufficient amounts of saliva. After being exported from Polar Pro Trainer 5™ 
statistical calculations were made and analyzed in software Microsoft Excel 2010 and Statistica, 
version 10. Some briefly manifested high heart rate artifacts, at frequencies between 200 - 250 beats 
/ minute were excluded before processing the material.

Ethical permission

Ethical permission for the study was obtained from the Regional Ethical Review Board in Gothenburg, 
2012-06-25 Dnr: 356-12. Permission to conduct the study was given by the relevant manager in the 
ambulance service. Before the study, participants received both written and oral information about 
the study and that participation was voluntary and could be cancelled without giving any reasons at 
any point in time. All participants signed a written agreement that they would participate. Data 
collection followed the principles of the Declaration of Helsinki [32].
Results

The effort phase runs between the first and second cortisol test, corresponding to fifteen minutes, and the recovery phase between the second and fifth sample, representing 45 minutes. Table 1 gives the median and range values for heart rates and salivary cortisol concentrations for the time points 0, 15, 30, 45 and 60 minutes after start of carrying the stretcher, grouped according to gender.

Effects of using shoulder straps

The use of shoulder straps when carrying a stretcher clearly shows that distributing the load over the whole body decreases the effort involved, resulting in lower heart rate and lower cortisol concentrations. There were significant differences seen in all phases (Figure 1). The overall physical effort of carrying a stretcher is indicated as the area under the curve, AUC, and is calculated as the average heart rates during each phase x time span. The results for 15, 45 and 60 minutes are presented. Significant differences are seen when shoulder straps are used (Figure 2).

In most participants (18/20) heart rates and salivary cortisol secretion/concentration decreased significantly and the return to normal resting heart rates in the recovery phase was quicker when shoulder straps were used. Individual differences in response to using shoulder straps were seen (Figure 3).

QS Individual participants characteristics:

Then the group was sorted according to gender there were no observed significant differences in heart rates in all phases. In men, but not in women, there was significance in the effort phase and in the total phase but not during the recovery phase. We had no significant differences between heart rate and/or cortisol concentrations and age.

We had wanted to estimate the metabolic condition and body mass index, waste circumference and hip, and the quote of waste and hip. The participant did not accept these estimations. Therefore, we have no information of comparisons.
Discussion

The first main finding in this study is that lifting aids in the form of the shoulder straps tested reduces the strain on the body resulting in lower heart rate and lower concentrations of the stress hormone cortisol. The second finding concerning the use of shoulder straps is that the participants could carry for a much longer time without setting down the stretcher and taking retakes. Participants often said spontaneously that they had less pain in their hands and arms when they used shoulder straps, which can be interpreted as shoulder straps really distributing the workload over the whole body in a positive way. One possible explanation for two individuals’ increased heart rate response and the lack of clear-cut benefit in using shoulder straps for same others might be that they were unaccustomed to using them, and that the shoulder straps may not have been optimally adjusted to the individual.

Q 1- Study aims;

Psychosocial aspects

If you will continue with the use of the shoulder straps there will be a mental effect and a positive effect of the psychosocial aspect. The participant’s sense of distress will be less and the LHPA response adjusted to a minimal increase in salivary cortisol concentration.

Psychological aspects

When you have ergonomic- optimal condition you will feel safe, and more confidence for the work. This will decrease the sense of stress with activation of LHPA axis and result in decreased cortisol concentrations. We have in other designed studies of ambulance personal found that somebody always have pronounced cortisol response and we think that this is a risk factor for a long work-occupation with risk for burn out and cardiovascular disease.

Generalizability

The comparison of participants and non-participants according to age span and gender shows no significant differences. The median age for all men and women who are employees was 42 and 41 years old respectively compared to 43 and 42 years old respectively for the participants in this study.
Of the 99 male employees and 65 female employees, 14 men and 6 women were included of whom 16 (80%) were nurses and 4 (20%) paramedics compared to 129 (79%) nurses and 35 (21%) paramedics in the whole group. The cohort studied seems to be representative for the whole group and results can probably be generalized for the whole group.

Consequences of these findings

It is important to implement these findings in daily work in the ambulance service. Stretcher carrying is in many cases reduced due to new and better adapted stretcher systems, but in a broader perspective, these shoulder straps may also be used when heavy equipment is carried to and from the patient. This type of carrying will probably increase as the number of ambulance missions and assessment missions requiring equipment at the place of care is increasing in most Swedish ambulance organizations. Occasions when it is necessary to carry patients become even more strenuous, partly due to heavier and more cumbersome stretchers but especially due to an increasingly heavier population. A tendency towards more equipment and equipment divided into separate units, including monitoring equipment that can be divided into up to four devices also means an increased risk. Every reduced workload on the body is valuable during a full professional life in the ambulance service [33]. Each organization should carefully consider what should be included in the equipment to be carried with consideration given to the weight. The equipment for emergency treatment and monitoring of patients in the organization where the study was carried out weighs between 25-30 kg.

The Swedish Work Environment Authority’s [3] current recommendation for the maximum weight to be lifted (25 kg) is exceeded many times daily in the Ambulance profession. This is true even more often in locations or environments neither designed nor intended as workplaces and during days and nights in all conceivable weather conditions. Usually, assignments must be solved by two members of staff who may be of varying age, gender, experience, education and physical ability. The strain often
come after the ambulance personnel have been sitting idly in the ambulance for a shorter or longer period and they are expected to act immediately without being able to warm up beforehand.

*Strengths and weaknesses*

The study has been well controlled since the study protocols were adhered to meticulously and all participants completed the tests. All participants were their own control. All participants carried out the test on the exact same route, carried the same stretcher and used the same shoulder straps, so they all participated in the same external physical conditions. A loss of only two cortisol series and a complete heart rate measurement guarantees a secure outcome.

The main weakness was the smallness of the group. Also, the small number of women participants prevented us from drawing firm conclusions based on gender differences. The recovery phase was unfortunately not the same for everyone as no demands were made to the participants to be in privacy and total rest during this time. Despite this, all spent the recovery phase in the same room.

*Conclusion*

The study shows clearly that the shoulder straps tested should be used when equipment and stretcher are to be carried. This investigation shows that this aid, simple in itself, reduces the physical effort resulting in both a decrease in heart rate and salivary cortisol concentrations. An easy way to ensure that staff use these or similar lifting aids is for staff to be given personalized, well adapted shoulder straps, or even better that the straps should be routinely sewn into the staff’s personal alarm jackets so they are always in place ready to be used.

*Future aspects*

A reasonable assumption, however one that has not yet being explored, is probably that the various types of backpack equipment bags in the ambulance service should also be carried like this as much
as possible. The effect of unloading the body would probably be similar to that of the shoulder straps investigated.

Although the survey has been conducted in the prehospital field, the results may be generalized, and may thus be transferred to other occupations with similar lifts.
Acknowledgments

The authors thank the Research found at Skaraborg Hospital, Skövde, for financial support which made this study possible. Furthermore we thank Björn Holmqvist AB Germa who kindly loaned us the shoulder straps tested. Many thanks to biomedical scientist Margaret Bouveng-Käck for excellent collection and processing of salivary cortisol samples. Also, many thanks to Margaret Myers for help with English proof-reading. Last but not least, many thanks to the participants in the study who completed the study with great commitment outside their working hours.

Declaration of interest

None of the authors has any conflicts of interest in this article. None of the persons listed in the acknowledgments have been involved in the design, processing, analysis, and interpretation of results and description of the results in the manuscript.

Authors’ contribution.

Kåre and Patrik; planning, implementation, statistics, preliminary script

Anders; planning, proof-reading

Carl-Johan; planning, responsible for salivary cortisol analyses, statistics, figures, supervision of the study.

All authors have had access to all the data in study, have read the final version and they accept responsibility for its validity.
Reference list:


To Article in SHAW.

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Legends to Figures.

Figure 1 Heart rate during carrying a stretcher and relaxation comparing the effect of using shoulder straps or not.

Figure 2 Area under curve from baseline, (AUC₀), representing total workload (heart rate*timespan) during carrying a stretcher and relaxation. Comparing the effect of using shoulder straps or not.

Figure 3 Salivary cortisol concentration (nmol/L) after carrying a stretcher with and without using shoulder straps.

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Table 1.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Male</th>
<th>Female</th>
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<tbody>
<tr>
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<tr>
<td>Straps</td>
<td>without</td>
<td>with</td>
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<tr>
<td>Time point (min)</td>
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<tr>
<td>Salivary cortisol</td>
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<td>N=13</td>
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<tr>
<td>(nmol/L)</td>
<td></td>
<td></td>
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<tr>
<td>0</td>
<td>21.9 (15.1-54.2)</td>
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<tr>
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<td>21.9 (14.5-45.2)</td>
<td>16.9 (11.2-32.9)</td>
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<td>30</td>
<td>24.3 (13.6-50.0)</td>
<td>16.0 (11.1-31.4)</td>
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<td>45</td>
<td>21.5 (12.6-45.0)</td>
<td>14.8 (10.7-26.5)</td>
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<td>60</td>
<td>20.5 (12.4-31.2)</td>
<td>15.7 (10.2-23.5)</td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
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<td>N=14</td>
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<tr>
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<td></td>
<td></td>
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<tr>
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<td>78 (60-95)</td>
<td>78 (54-88)</td>
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<td>93 (70-108)</td>
<td>85 (60-104)</td>
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<td>82 (59-103)</td>
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<tr>
<td>45</td>
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<td>76 (53-90)</td>
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<tr>
<td>60</td>
<td>73 (61-90)</td>
<td>76 (54-94)</td>
</tr>
</tbody>
</table>
Table 1

Salivary cortisol concentrations (nmol/L) and heart rate values (bpm) before (0), during (15) and after (30-60) carrying a heavy stretcher with and without shoulder straps. Values are given as median and range.
Work without Relaxation
All time
Work with Relaxation
All time

40 60 80 100 120 140 160 180 Heart rate

1 p=0.002
2 p=0.024
3 p=0.005

- Median
- 25%-75%
- Non-Outlier Range
- Outliers
- Extremes
Figure 2
Comparison of carrying with and without a strap

Salivary cortisol (nmol/L)

1= without strap, 2= with strap

** *=p<0.0001