The Role of Anthropometric Measures on the Musculoskeletal System of Workers Performing Heavy Physical Work

Klaus UNDEUTSCH
Hospital for Cardiovascular Diseases and Occupational Health,
5920 Bad Berleburg, West Germany

In an epidemiologic cross-sectional study, 366 transport workers who were engaged in heavy physical work in uncomfortable body positions in narrow freight spaces of airplanes were investigated with regard to their subjective and objective musculoskeletal complaints by a standardized interview and an additional clinical orthopedic examination.

Back and knee complaints were the most frequently reported complaints. The prevalence of back pains increased with age and stature significantly, the prevalence of knee pains with age and weight. In contrast to these subjective complaints the objective findings of the clinical examination showed very little influence upon anthropometric measures such as body weight and stature.

Key words: Anthropology, Orthopedic Complaints, Physical Heavy Work

INTRODUCTION

Heavy physical work and its health impact are a very discussed topic today. An important question in those discussions is the influence of anthropometric measures such as body weight and stature.

The present study is dealing with transport workers and their work. The loading and unloading of airplanes still involve heavy physical work, which often has to be done under a very low ceiling in bending positions (Fig.1). The height of the freight spaces differs between 85cm and 165cm.

To get more detailed information about the musculoskeletal health situation of transport-workers and the influence of anthropometric measures such as body weight and stature, an epidemiologic cross-sectional study was carried out to find out the long-time effects in term of complaints and illnesses of the locomotor system.

MATERIAL AND METHODS

Subjects
At a large airport about 800 men are engaged in loading and unloading the aircraft flying passenger and cargo routes. Nearly half of this population served as subjects in the study. The mean age of the 336 workers, participating in this study was 36 (±8 years SD) and the range was from 19-61 years.

Methods
Case History Study
The transport workers were questioned by two
doctors by means of a standardized interview (according to Wickstrom et al., 1978) on previous and present complaints of the musculoskeletal system. Doing so, detailed information on neck, arm, back, and leg-complaints of the workers were collected. A priority in this interview was given to back troubles. Back trouble or back insufficiency was defined as the appearance of one or several of the following symptoms: stiffness, fatigue, ache or sharp pain. Lumbago was defined as a sudden attack of back pain not radiating into one or both legs, but causing stiffness in the back; and sciatica was defined as an attack of back pain radiating into one or both legs.

Clinical orthopedic examination

In 134 out of these 336 transport workers, a standardized clinical orthopedic examination was performed. The following functional examination methods were used: observation, assessment of active and passive movements, isometric muscle contraction against resistance, muscle stretching and palpation for muscle tone, hardening, and sore spots.

Isometric muscle strength measurements

In order to describe the population under study, isometric strength measurement of several muscle groups with a special dynamometer was carried out in 70 workers (Fig. 2):
- trunk flexors
- trunk extensors
- muscles involved in bimanual vertical lifting
- right muscle biceps brachii
- right triceps brachii

For measuring the strength of the muscles a strain gage dynamometer and a load amplifier were employed. At all the strength measurements the

![Diagram](image-url)
output of the amplifier was fed into a peak value storage memory, which stored the maximum value of each analog voltage and displayed it in digital form.

RESULTS

During ordinary workdays of the past four weeks 66% of the interviewed workers experienced back symptoms (present back complaints) (Fig. 3).

The prevalence of these symptoms did not show any significant differences for the age groups until the age of 45; but it increased markedly thereafter (P = 0.03).

According to height the prevalence increased significantly; 53% of the persons with stature of less than 164 cm showed back symptoms, as did 73% of the persons with a height of more than 178 cm. With longer duration of work experience in the present occupation, the prevalence of present back complaints increased significantly (p=0.035). No significant relation could be demonstrated between total physical work experience and back complaints and between body weight and back complaints.

To show the independent influence of each of the factors such as age, stature, weight and duration of transport work experience, partial correlation was carried out. By this analysis all factors except the very one of interest were kept in balance: stature revealed as the strongest factor; the duration of transport work also showed a significant correlation with the prevalence of back symptoms. On the other hand, age and body weight showed no significant influence in this partial correlation.

Back complaints at some time in life (previous back syndrome) were reported by about 56% of the transport workers. The prevalence of previous back symptoms increased significantly from the age of 45 years onwards (P = 0.02). There was significant

---

**Fig. 3.** Prevalence (%) of present back complaints (usually present during an ordinary working day). [The percentages relate to each subpopulation (n=100%)]
positive correlation between the prevalence of back symptoms and stature (P=0.048).

The previous back complaints were classified in the syndromes of back insufficiency, lumbago and sciatica. Table 1 shows the prevalence of these back syndromes and their combinations by age groups. Back insufficiency was reported by about 50%, lumbago by about 17%, and sciatica by about 9%. Of the 182 persons with back insufficiency, 26% complained also of lumbago, 13% also of sciatica; 2% reported both lumbago and sciatica. All back syndromes and their combinations showed an increasing prevalence according to age groups.

The average of first appearance was 32 years for back insufficiency, 33 years for lumbago and 35 years for sciatica. The association between duration of transport work and prevalence of previous back syndromes was - when controlling age - not significant.

Knee complaints followed in the prevalence of locomotor complaints next to back complaints and were reported by 41% of the transport workers. There was an increasing prevalence of knee complaints with age, specially commencing the age of 45. In contrast to back pains the prevalence of knee complaints correlated significantly with body weight (Table 2). Workers in the highest body weight group with an overweight of more than 20% of their normal body weight (following Broca-Index) reported in 62% knee complaints, in the other four body weight groups only in 37% to 39%. The correlation between weight and the prevalence of knee complaints was significant (p=0.036). When BMI (Body-Mass-Index) was taken into account, the worker of the upper 20 percent with a BMI > 27.72 reported in 52% complaints, workers with a BMI < 27.72 in 38% (Fig. 4). The correlation between knee complaints and BMI was also significant.

In partial correlation, body weight and duration of work experience in present job showed a significant correlation to the prevalence of knee complaints.

Neck complaints were reported by 33%, arm complaints by 41% of the workers. The prevalence of neck as well as of arm-complaints showed only significant correlation with age.

The prevalence of objective clinical findings in different parts of the locomotor-system was generally as high as the prevalence of reported complaints in the interview. In contrast to the subjective data of the interview there was no significant influence of the prevalence of clinical findings on age, body weight, stature and duration.

### Table 1. Prevalence of back syndromes and its combinations by age

<table>
<thead>
<tr>
<th>Age groups (years)</th>
<th>24</th>
<th>25-34</th>
<th>35-44</th>
<th>45+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back insufficiency (n=182)</td>
<td>46.9</td>
<td>46.0</td>
<td>51.3</td>
<td>56.9</td>
</tr>
<tr>
<td>Lumbago (n=63)</td>
<td>12.5</td>
<td>16.1</td>
<td>17.7</td>
<td>21.6</td>
</tr>
<tr>
<td>Sciatica (n=33)</td>
<td>3.2</td>
<td>8.9</td>
<td>9.5</td>
<td>12.0</td>
</tr>
<tr>
<td>Back insufficiency &amp; lumbago (n=47)</td>
<td>9.4</td>
<td>14.5</td>
<td>12.7</td>
<td>11.8</td>
</tr>
<tr>
<td>Back insufficiency &amp; sciatica (n=24)</td>
<td>0</td>
<td>6.5</td>
<td>7.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Lumbago &amp; sciatica (n=8)</td>
<td>0</td>
<td>0.8</td>
<td>3.2</td>
<td>4.0</td>
</tr>
<tr>
<td>Back insufficiency &amp; lumbago &amp; sciatica (n=8)</td>
<td>0</td>
<td>0.8</td>
<td>3.2</td>
<td>4.0</td>
</tr>
</tbody>
</table>
Table 2. Prevalence of knee complaints according to body weight

<table>
<thead>
<tr>
<th>Weight groups:</th>
<th>ideal</th>
<th>normal up to 10%</th>
<th>up to 20%</th>
<th>above 20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence(%)</td>
<td>37.0</td>
<td>38.1</td>
<td>39.2</td>
<td>37.7</td>
</tr>
</tbody>
</table>

Fig. 4. Prevalence of knee complaints according to Body-Mass-Index

of work experience in present job.

First analysis of the muscle strength measurements showed significant negative correlation of the five relative muscle strengths (N/kg) and body weight. The correlations between stature and relative muscle strengths were not significant. Partial correlation however revealed in a strong negative effect of age on the relative muscle strength; body weight did not show significant influence on the relative muscle strength in this partial correlation (Undeutsch et al., 1982). Further analysis showed no correlation between the relative muscle strength and prevalence of locomotor complaints. The results led to the conclusion that higher muscle strength is no prevention factor for the prevalence of locomotor complaints.

**DISCUSSION**

According to our results, the question arises as to what extent anthropometric measures could be a risk factor for back symptoms and knee complaints. Three epidemiologically oriented studies by Hult (1954), Rowe (1971) and Chaffin and Park (1973) revealed no specific risk in back syndromes for thick and thin or tall and small subjects. For special jobs the situation may be different. The airport transport workers do their job in a narrow and low space. Therefore it is no wonder, that in our study the taller subjects had a higher prevalence of back symptoms and with increasing weight a higher prevalence of knee complaints.

Musculoskeletal diseases present themselves at different stages of the disease, whereas severe signs and findings are seldom in a population and slight symptoms and signs are common. Musculoskeletal symptoms show a high prevalence with increasing age and it is often difficult to draw a line between a pathological symptom and a physiological aging phenomenon.

Nachemson (1971) and Rowe (1969) considered most cases of low-back disorder as arising from intervertebral disc degeneration, but this view has not yet become general acceptance. Magora (1973), for example, found an association between the incidence of back pain and a variety of psychological factors. Nachemson (1971) estimates that 70-80% of the general population suffers from disabling low-back pain at some time in their lives. Furthermore, a majority of the attacks occur during the working ages (20-55 years), with the first medical attack most often reported between the ages 20 and 30.

The present working population may be considered as particularly interesting for a cross-sectional study of the relations of the strength of different muscle groups to age. All men did the same kind of manual work and were thus subjected to similar training stimuli. Their age range was fairly large. The work, although heavy at times, allowed for frequent pauses and the labour turnover was not excessive. After an initial selection there was no evidence for leaving the job because of insufficient muscle strength. The present method of muscle strength measurements differs from those used by most other investigators in placing the subjects in more fixed positions and in keeping them more immobile. The differences in methods probably
caused slight systematic differences in results in comparison to other investigation.

Body weight and stature showed no influence in relation to the prevalence of orthopedic findings in the clinical examination. It is supposed that clinical locomotor findings will be foregone by longer periods of subjective complaints which already lead to selection of workers (job-change) with clinical orthopedic findings.

CONCLUSION

Airport transport work has to be done under very narrow circumstances. These conditions of work are not satisfactorily solved from the ergonomic point of view. The fact however, that the work is performed irregularly with long pauses is advantageous, because of lesser probability of fatigue of the musculoskeletal system and also of better chance to recover.

Because of the higher prevalence of orthopedic complaints with age, increasing stature and body weight, we recommend to choose younger and smaller persons without overweight. The aim for the future should be, however, to increase the height of the freight spaces.

REFERENCES

(Recieved April 11, 1984)