

A Video-Based Observation Method to Assess Musculoskeletal Load in Kitchen Work

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This paper describes a new video-based observation method aimed to assess musculoskeletal load in kitchen work, aspects of its repeatability and validity, and problems confronted by the observers. Two pairs of researchers observed individually 117 video clips recorded in kitchens. Interobserver repeatability was assessed by computing the proportion of agreement and weighted kappa values (κ_w). Validity was analyzed by studying the distribution of the assessments over the rating scales and the ratings before and after the interventions, which were compared with expert assessments made from the same intervention targets. The proportion of agreement ranged from 57 to 88%. Interobserver repeatability based on weighted kappa values was mainly good to moderate. The method detected the changes in physical load due to the interventions. Direction of the changes corresponded with the expert assessments. Further development of the method is needed to assess the load on the hands and wrists.

ergonomics exposure posture force repeatability validity

1. INTRODUCTION

Work in a professional kitchen imposes dynamic and static loading on the whole musculoskeletal system. It typically involves various parallel tasks, each relatively short. Physical exposures include awkward postures, manual material handling, and repetitive and forceful movements [1, 2, 3]. Of the psychosocial factors, working under time pressure and low job control are characteristic for kitchen work [2]. In addition to high exposure level, kitchen workers have a high prevalence of disorders in the back, shoulders, and upper extremities [4, 5, 6, 7, 8]. In general, there are very few studies on kitchen ergonomics or on the health of the kitchen workers.

In ergonomic studies, observation methods are preferred over self-reports because of their

better validity and reliability. A wide variation of observation methods has been used, but no universal method for all kinds of jobs exists yet [9, 10]. Whole-body observation methods generally assess the load in the low back, shoulders, and lower extremities. These methods may, however, lack the assessment of hands and wrists [11, 12], or it is done by observing wrist angles [13, 14, 15, 16], which has been found to be challenging, especially in fast-changing tasks such as kitchen work [17, 18]. The type of grip has been accounted for in a few studies only [17, 18, 19].

The available methods typically concentrate on assessing work postures, whereas fewer methods provide tools to assess frequency, duration, or force [20]. These work features co-occur and interact, but observing and recording their simultaneous occurrence has not been possible

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with current methods. In some methods, such as rapid upper limb assessment (RULA) [16] and quick exposure check (QEC) [14], risk factors are observed separately and the exposure levels for different risk factors are further combined to a score [14, 15, 16, 21]. In these methods, the weighting of the exposures has shown to be problematic [14]. The reliability and validity have not been studied for several methods. Further, information on the problems encountered by the users of a method is rarely reported [10].

In the selection of an appropriate method, the nature of the work (i.e., dynamic or static work, monotonous or varied work tasks, the body areas affected) and the desired precision level of the measurement need to be identified [22]. Relatively simple methods, such as checklists, can be employed for rapid identification of the risk factors. For assessing changes in work load, e.g., before and after an ergonomic intervention, more detailed information is needed.

In a randomized intervention trial aimed at reducing physical loading in kitchen work, changes in physical exposures were observed before and after the intervention with the use of video recordings. Given the precision level required to detect these changes and the specific nature of kitchen work, the already existing methods did not prove applicable. Hence, we developed a new observation method, kitchen

intervention work load assessment (KILA). This paper describes the method, the systematic testing of its repeatability, aspects of its validity, and problems confronted by the observers.

2. MATERIAL AND METHODS

A cluster randomized intervention trial targeted at ergonomics in kitchen work was carried out in 2002–2005 in Finland [23, 24]. Altogether 119 municipal kitchens were randomized to an intervention ($n = 59$) and control ($n = 60$) group. The intervention was carried out using the participatory approach. Experts in ergonomics supported and guided this process. During the intervention phase 402 ergonomic changes were implemented. To assess the possible changes in physical work load, we recorded on video before and after the intervention those changes that would in general be detectable on video (e.g., changes in working surface levels, methods, and equipment).

2.1. The Observation Method

Observations were performed in real time from videotape. The assessment of the loading on the low back, shoulders, and hands and wrists was based on postures, time aspects (duration and frequency), and force requirements (Table 1).

TABLE 1. Classification Criteria for Assessing Postures and Force Requirements

Assessed Factor	Low Back	Shoulders	Hands/Wrists
Posture	neutral flexion: $<20^\circ$, 20° – 60° or $>60^\circ$ twist or lateral bend: $\leq 20^\circ$ or $>20^\circ$	angle between trunk and upper arm: $\leq 20^\circ$ $>20^\circ$, but $<45^\circ$ 45° – 90° $>90^\circ$	no grip or very light grip power grip narrow grip (e.g., pinch grip) or extensive grip double grip (precision grip in radial fingers combined with simultaneous power grip in ulnar fingers)
Time	occasional repetitive/continuous	occasional repetitive/continuous	occasional repetitive/continuous
Weights handled/force needed	<1 kg ≥ 1 kg, but <5 kg ≥ 5 kg, but <10 kg ≥ 10 kg, but 20 kg ≥ 20 kg	no load ≤ 0.5 kg >0.5 kg, but ≤ 4 kg >4 kg, but ≤ 10 kg >10 kg	light (e.g., sorting cold cuts) somewhat heavy (e.g., stirring soup) heavy (e.g., scooping food) extremely heavy (e.g., lifting 20-kg sack)

The combination of the main posture and its duration and frequency were ranked on a scale of 7 categories (Appendix 1). Each shoulder and hand was assessed separately.

The cut-off values for the rating categories were selected on the basis of the literature. The classification of postures of the back and shoulders was based on RULA and QEC [16, 20]. The loading of the hands and wrists was assessed by the type of grip.

The posture or grip was considered to be repetitive or continuous if it occurred several times during the observed period and lasted more than half of the observed time. Otherwise the posture or grip was labeled occasional. Similar criteria have been used for repetitiveness in earlier methods [17, 25, 26].

Kitchen work includes several tasks in which the force requirements cannot be assessed by merely considering the weight of the object. For example, the force needed in stirring and

scooping depends on the texture of the food. In the KILA method, the force requirements were rated into 4 or 5 classes by the weight handled or the force needed. The cut-off limits for the back and shoulders were established according to RULA and QEC [16, 27]. For the shoulders, the weight of the object or the force needed was halved if the load was handled with both hands. To facilitate the assessment of the force requirements of the hands, examples of subtasks in kitchen work were provided to the observers (Table 1).

2.2. Assessment of the Repeatability and Validity of the Method

Interobserver repeatability was assessed by comparing the assessments of two observers who observed the same video clip simultaneously (Figure 1). Content validity was described by the distributions of the consensus assessments

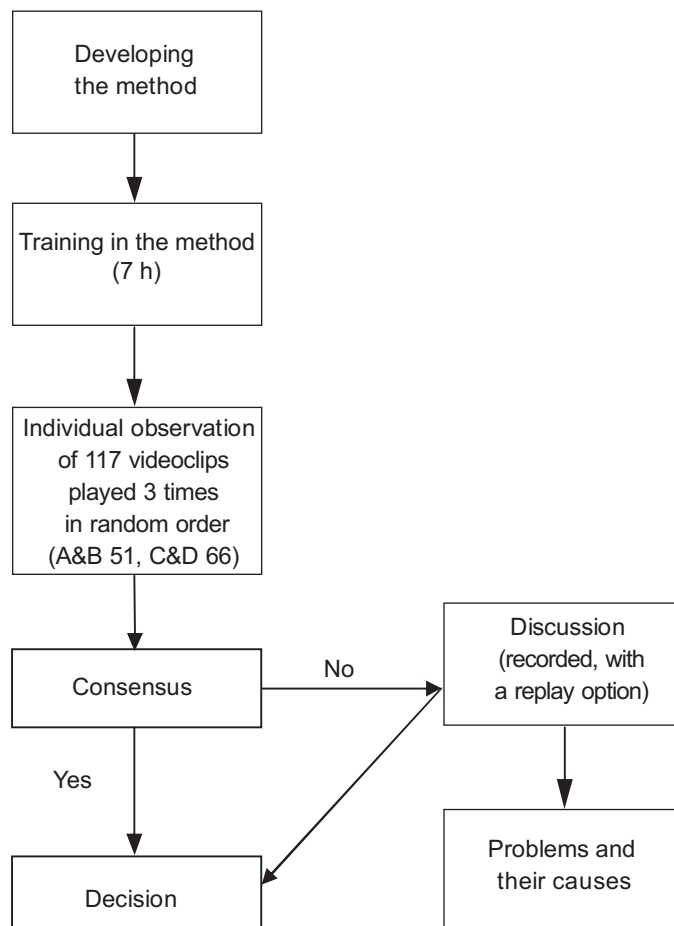


Figure 1. Flowchart of the study.

over the rating scales of the observed factors to see how the method covered the observed phenomena. Another aspect of content validity—how the method measured the changes due to the interventions—was described by the differences in ratings between the situations before and after the intervention. Concurrent validity was described by comparing the direction of the changes with the expert assessments. In addition, we collected data on the difficulties encountered during the observation.

2.2.1. Observers and training

All four observers (A, B, C, D) were physiotherapists familiar with kitchen work. To keep them blinded to the interventions, each pair observed recordings from kitchens with which they were not familiar. Experience in the use of other observation methods was 2 and 3 years for observers A and B (A&B) and 20 years for C and D (C&D). The observers familiarized themselves

with the method using a written guide. During a 7-h training session they practiced observing by looking at sample pictures and watching video clips from kitchen work which were not included in this analysis. A modified Delphi technique was used to reach agreement on the criteria [28].

2.2.2. Material and observations

The video clips were recorded in real work situations with one camera and mainly from the sagittal view of the whole body of the worker. The observers assessed 50 situations before and after the intervention. Table 2 presents the observed clips by work tasks and observer pairs, and Table 3 the main targets of the interventions with some examples. Moreover, 13 clips were divided into 2–4 shorter clips, because the task consisted of different subtasks. The total number of clips analyzed was 117. Observer pair A&B observed 66 clips and C&D 51 clips. The median duration of the clips was 68 s (range: 8–433 s).

TABLE 2. Observed Changes ($n = 50$) by Tasks and Observer Pairs (A&B and C&D)

Task	A&B	C&D	Total
Preparation	1	1	2
Cooking and baking	3	4	7
Distributing and serving of food	8	6	14
Packing food to be delivered to clients	3	1	4
Dishwashing	6	4	10
Cleaning and maintaining room and equipment	3	8	11
Receiving and storing raw material	—	2	2
Total	24	26	50

TABLE 3. Main Targets of the Interventions With Examples

Main Target of the Change	No. of Changes	Examples of Changes
To decrease the weight of the lifted object	6	purchasing a 10-L milk container instead of a 20-L one
To reduce the number of liftings	7	using the same cart for gathering and transferring dishes using a hose to fill the water dispenser purchasing platforms on wheels to use under heavy sacks and other containers to facilitate moving them when cleaning the storeroom removing a doorstep to facilitate the use of carts when moving groceries into the storeroom
To reduce awkward postures	29	optimizing the working height in preparing, cooking, and packing food, and in dishwashing using a mop to clean tables
To reduce repetitiveness	4	tilting the pot instead of scooping food when moving food from the pot into the pan
To eliminate work tasks	4	purchasing a new electronic mixing pot
Total	50	

The information on the duration of the clips and the weights handled was given to the observers before viewing a new clip.

Each observer first conducted the assessment individually, without discussing it with their partners. The clips were shown in random order without information on the interventions applied. Each clip was played three times to improve the precision of the observations. At first the observers were guided to observe the low back, in the first replay they were told to focus on the shoulders, and in the second replay on the hands.

After the individual assessment of each task, the observers discussed their assessments and made a unanimous decision. If they did not agree, they justified their views and reported the difficulties they had experienced during the assessment. Then they were allowed to view the clip again. The discussions of the observer pairs were recorded on minidisk.

2.2.3. Expert assessment of the changes

During the intervention phase the experts in ergonomics interviewed the workers, examined the changed in the work tasks, and performed physical measurements (e.g., of working surface levels or materials handled). Accordingly, they thoroughly documented the implemented changes and made expert assessments of the effects of the intervention on the loading of the low back, shoulders, and hands and wrists using a 7-point rating scale (−3—*highly increased loading*, 0—*no effect*, 3—*highly reduced loading*). Expert assessment was available in 82% of the changes observed with the KILA method.

2.2.4. Data analysis

Interobserver repeatability was assessed by computing the proportion of agreement and weighted kappa values (κ_w) with their 95% confidence intervals using SAS version 9.1 [29, 30]. The weighted kappa takes into account the magnitude of the disagreement among observers. The weighted kappa values were classified according to Fleiss [31]: $\kappa_w < .40$ was regarded as *poor*, $.40$ – $.75$ as *moderate to good*, and $>.75$ as *excellent*.

Frequencies and proportions were used to describe the distributions of the consensus assessments over the rating scales, before and after the changes, and in the comparison of the observations with the expert assessments. The magnitude of the data was insufficient for a meaningful formal statistical analysis.

One of the authors (IP) studied the recordings of the discussions and classified the problems stated by the observers.

3. RESULTS

3.1. Interobserver Repeatability

Observer pair A&B made 647 observations and C&D 492 observations. A&B were not able to rate 13 observations and C&D 18, because they could not see, e.g., both hands or both shoulders of the worker on the video.

The proportion of the agreement for A&B ranged from 57 to 88% and for C&B from 60 to 85% (Table 4). A&B had better agreement than C&D for all loading factors except grips. According to the weighted kappa values, the interobserver repeatability of A&B was *excellent* for back force ($\kappa_w = .83$) and for the force of the right shoulder ($\kappa_w = .80$), and *moderate to good* for all other loading factors ($\kappa_w = .51$ – $.72$) except for the grip of the right hand ($\kappa_w = .30$), which was *poor*. The repeatability of C&D was *excellent* for back force ($\kappa_w = .80$) and *moderate to good* for other loading factors ($\kappa_w = .51$ – $.72$).

When the observers disagreed, the values usually differed by no more than one class (in 75–100% of the observations, depending on the observed factor). Disagreements of more than one class often occurred in situations in which the observers' concepts of time aspects differed.

3.2. Validity

The observed data comprised video clips from all seven main tasks of kitchen work identified in the intervention study (Table 2). Figure 2 shows the distribution of ratings over the observed factors before and after intervention. The ratings were distributed over the entire scales of the method.

TABLE 4. Interobserver Repeatability Between Observers A&B and C&D: Agreement (%), Weighted Kappa Values (κ_w) With 95% Confidence Intervals (CI), and Ratings From *Poor* to *Excellent* as Proposed by Fleiss [31]

Observed Exposure	A&B			C&D		
	Agreement (%)	κ_w (95% CI)	Rating of Agreement	Agreement (%)	κ_w (95% CI)	Rating of Agreement
Back posture	70	.72 (.60–.84)	<i>moderate to good</i>	62	.61 (.44–.78)	<i>moderate to good</i>
Back force	88	.83 (.72–.94)	<i>excellent</i>	78	.80 (.68–.91)	<i>excellent</i>
Shoulder posture left	66	.61 (.45–.78)	<i>moderate to good</i>	60	.59 (.42–.77)	<i>moderate to good</i>
Shoulder posture right	72	.54 (.34–.74)	<i>moderate to good</i>	64	.66 (.51–.82)	<i>moderate to good</i>
Shoulder force left	80	.75 (.63–.88)	<i>moderate to good</i>	62	.68 (.56–.81)	<i>moderate to good</i>
Shoulder force right	83	.80 (.70–.90)	<i>excellent</i>	69	.68 (.56–.81)	<i>moderate to good</i>
Grip left	71	.51 (.31–.71)	<i>moderate to good</i>	77	.62 (.39–.84)	<i>moderate to good</i>
Grip right	57	.30 (.09–.50)	<i>poor</i>	85	.51 (.25–.78)	<i>moderate to good</i>
Grip force left	77	.67 (.51–.83)	<i>moderate to good</i>	74	.70 (.56, .84)	<i>moderate to good</i>
Grip force right	74	.62 (.45–.79)	<i>moderate to good</i>	70	.64 (.48, .81)	<i>moderate to good</i>

The only rating categories missing from the observations were class 7 of back postures (the back is repeatedly or continuously simultaneously bent more than 60° and twisted or laterally bent more than 20°) and class 4 of grips (occasional double grip).

After the intervention, the proportion of repetitive or continuous awkward postures of the low back (categories 4–7) and upper extremities (categories 5–7) decreased, as did the load handled or force needed, whereas the percentage of repetitive and continuous grips (categories 5–7) increased.

According to the expert assessment, 80% of the changes in work load led to a reduction in the loading of the low back, 63% in the shoulders,

and 49% in the hands and wrists (Figure 3). Furthermore, 15% of the changes had no effect on the loading of the low back, 37% on the loading of the shoulders, and 51% on the loading of the hands and wrists. In 5% of the changes, the loading of the low back increased. The direction of these assessments corresponded to the results gained through the KILA method, which generally shows a shift to a lower load (Figure 2).

3.3. Problems in Observation

Observers A&B reported difficulties in 22% of the observations and C&D in 21% of the observations. Altogether 10 reasons for these difficulties were distinguished (Figure 4). Most problems were encountered when defining

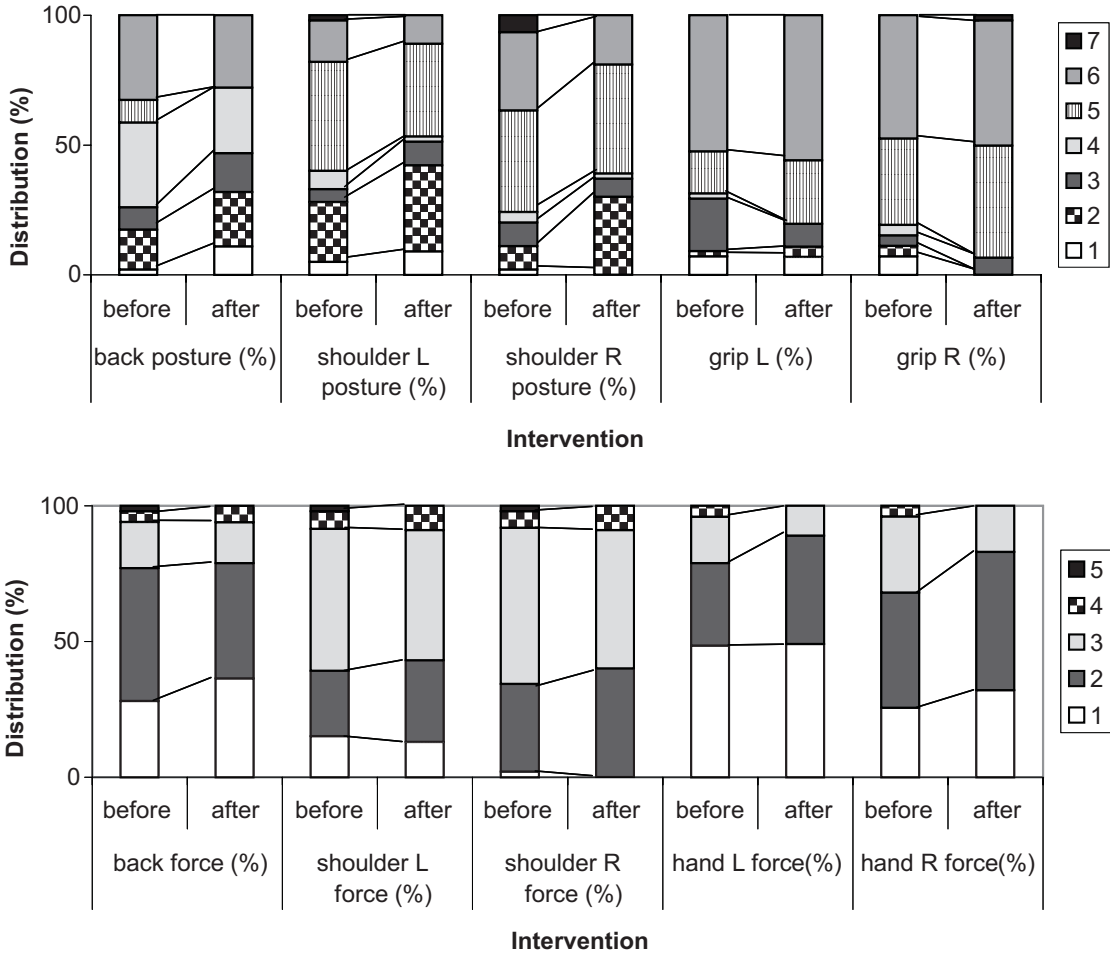


Figure 2. Distribution of ratings (1–7 or 1–5) before and after intervention. Notes. The direction of the lines between the before and after bars shows the shift of the distribution: upwards means reduction of the loading (back and shoulder postures and forces), downwards means shift to a higher load (grips).

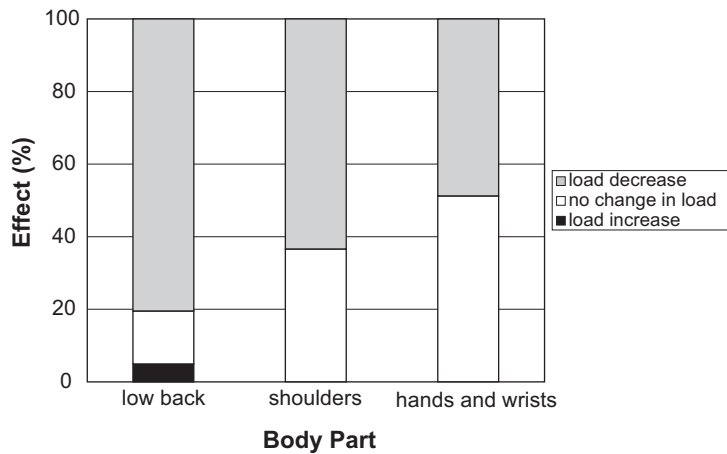


Figure 3. Effect of the implemented changes ($n = 41$) on the loading of the low back, shoulders, and hands and wrists according to the expert assessments.

the time aspects of the postures or grips (i.e., whether the observed factor was occasional or continuous). The observers considered it difficult

to assess the force requirements and grips when, e.g., a worker wiped tables, pushed trolleys, scrubbed a casserole dish, or scooped food into a

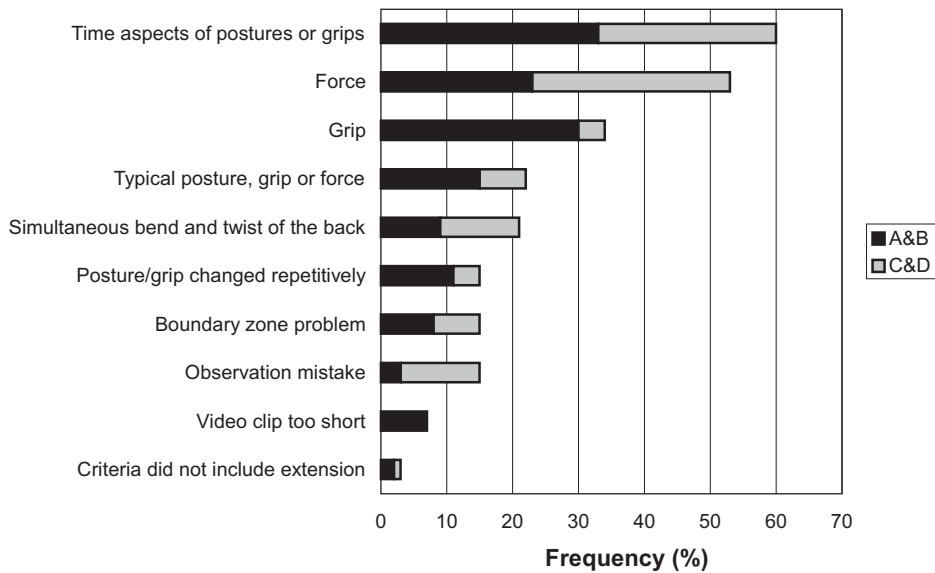


Figure 4. Frequency of problems classified by issue. Notes. Observer pair A&B reported 141 difficulties, C&D reported 104 difficulties.

casserole. Observer pair A&B had more problems in assessing grips than did C&D. The observers were guided to focus on the main and typical postures, grips, and forces, but in some video clips they experienced difficulties in deciding which one was the main or typical posture or force. Also, back postures with simultaneous bending and twisting or lateral bending were difficult to assess. Other problems occurred if the posture or grip greatly changed during the task, if the observed factor was in the boundary zone of the categories, or if the clip was too short in relation to the whole task. Errors mostly occurred while assessing force: the observers occasionally neglected to halve the load when the worker was handling it together with a co-worker or by using two hands. In one case, the back and in two cases the upper extremities were in extension, which was not included in the rating categories of the method.

4. DISCUSSION

A new method was developed to assess the physical work load in kitchen work. The interobserver repeatability of this method was mainly *good* or *moderate*. It detected changes in musculoskeletal risk factors, and the changes were in step with other measures. Most

difficulties were encountered when the observers assessed the force requirements and time aspects of the postures or grips.

Numerical estimates for the reliability of the observational methods have varied across methodological studies. In the literature, possible explanations for the differences have been suggested to be related to the observers' training, the observation criteria, and difficulty of the observed material (e.g., the number of events occurring on the boundary zone between two categories) [32]. In the present study, the observers A&B had a higher proportion of agreement than C&D in 8 of the 10 factors, even though they had less experience with other observation methods than the other pair. One reason could be that A&B had recently observed kitchen work as a pair and shared a common experience. This result is consistent with previous studies in which experienced observers were not more competent than less experienced ones [32, 33]. On the other hand, C&D had better agreement than A&B in assessing grips, which can also be explained by previous experience: C&D had a great deal of experience in assessing hand loads, whereas A&B had hardly any.

Regarding the disagreement between the observers, the ratings generally did not differ by more than one class. The obvious reason

for larger differences was usually a dissimilar conception of the time aspect. The observers had difficulties in distinguishing between occasional and continuous postures, especially when the duration was close to the cut-off point (half of the observed time). The boundary zone problem and difficulties in assessing the duration of tasks was also noted and discussed in several earlier studies [18, 32, 34, 35, 36]. Agreement between the observers can be expected to be better when the number of exposure categories is low. Several categories are, however, often needed to receive more detailed information. In such a case, a thorough definition of the categories is essential.

In line with previous studies [34], all observers had problems in assessing back postures when the back was simultaneously bent and rotated. It also seemed difficult to assess the force requirements in tasks in which the force requirements were affected by factors other than the weight of the object. For example, in wiping tables and pushing trolleys, one factor is the smoothness of the surface. Our method supported the assessment of hand load by giving examples of kitchen work. However, even then the assessment was difficult if the observers were not well familiar with the observed task. These findings are in accordance with previous experience, e.g., in carrying, the applied force can be estimated quite accurately by the weight of the object, but in pushing, pulling, or gripping it is less obvious. To obtain an unbiased assessment, direct measurements should be used to supplement the observation of force requirements for grips, and for pushing and pulling [37, 38].

The concept of validity has several aspects [39, 40]. In this study, mainly content validity was analyzed. The factors and cut-off limits for the categories were selected on the basis of previous research. The relevant issues for observing physical loading in kitchen work were included in this method. The observations also covered a wide range of exposure levels in the variety of relevant tasks. Even though some categories were rare or not used at all—including category 7 for the back and categories 4 and 7 for grip—those postures may occur in kitchen work, hence we consider it important to retain them in the scale.

An assessment of mechanical exposure should include three dimensions: the level of intensity, repetitiveness, and duration of exposure [22]. Our method combines the assessment of the posture or force requirements with the time aspects (frequency and duration). To keep the ratings feasible for the observers, the time aspects were built into the scoring of the categories. The method emphasizes the importance of both duration and repetitiveness of a loading factor. Our method is based on the assumption that a less awkward posture with long duration or high repetitiveness may be more loading than a more awkward posture that lasts for a short time or is not often repeated [22, 41].

Concurrent validity has often been assessed by comparing an instrument with a gold standard. Unfortunately there is no golden standard for assessing musculoskeletal loading at work. Therefore, we assessed the ability of the method to detect changes by comparing the direction of the changes with those identified in expert assessments. The study design, i.e., keeping the observers unaware of the interventions and showing the videos in random order, minimized systematic observational bias. The observations showed differences between the situations before and after the interventions, reflecting the changes in work load. The direction of the changes in work load was mainly in accordance with the expert assessments and other data on the interventions. The postural load and force requirements mainly decreased in the back and shoulders after the intervention. The results of the expert assessment and the KILA method are, however, not directly comparable. The experts assessed the changes in a more general manner, whereas in the KILA method, a particular worker performing a specific work task is observed.

Sometimes the incomplete video material prevented the observers from making assessments. Our videos were recorded only with one camera and mainly from the sagittal view. The viewing angle was not always optimal for detecting postures. The dimension of the kitchen was often the reason why the view was nonoptimal. Another problem arising from the use of a single camera is the difficulty to observe

all parts of the body from the same viewing point. Flexion and extension of the back can often be appropriately assessed from the sagittal view, but it may be impossible to see the opposite extremities behind the body [36]. However, the use of two cameras would often have been difficult in kitchens, because the spaces are regularly narrow and workers need to be able to move around during the observations.

The observations were made in real time from videotape. Direct observation has been claimed to be more accurate than video-based observation when assessing postures, because it is easier to obtain optimal viewing angles by moving around [18, 34]. However, when the pace of the observed task is fast and the number of assessed variables high, such as in kitchen work, video-based analysis with options for slow motion and replay is more appropriate [38, 42]. In this study, slow motion or freeze-shots were not used, but the observers had the opportunity to see the clips three times, which made it possible for them to concentrate on one body part at a time. The number of replays was usually considered adequate. Further replays would have been needed when the work postures changed rapidly and the clip was short. Even though time-sampling has been widely used in observation methods, the real-time procedure offers more accurate information about the sequence, duration, and frequency of the activities [33]. In addition, an assessment of dynamic work has been perceived to be more difficult than an assessment of static work [43]. In the present method, observation in real time enabled linking the time aspects with an assessment of posture and hand grip.

The video-recordings were made in actual work situations. For this reason it was sometimes impossible to record the same worker before and after the intervention with the consequence that the anthropometric dimensions and work habits of the workers could have affected the results. Unfortunately, we were not able to study the effects of different interventions on physical work load with multivariate analysis, because the number of observations was too small to achieve sufficient statistical power.

We tried to evaluate the loading of the hands on the basis of grips because accurate observation of wrist angles proved to be difficult [17, 18]. Even assessing grips seemed to be challenging, especially from video-recordings. One reason was that grips changed rapidly in kitchen work. The observers sometimes found it difficult to assign grips into the three predefined categories. The hook grip [44], a typical grip in kitchen work, was not included in the method. The results of the observations showed an increase in the loading on the hands and wrists, whereas the experts did not report similar effects. Thus we acknowledge that the criteria for assessing wrist and hand loading need to be further clarified and developed.

5. CONCLUSIONS

This new method demonstrated adequate reproducibility and validity to be used for assessing changes in physical loading due to interventions in kitchen work. It also seems to be usable for comparing the physical loading caused by different working practices or processes. The method was developed for kitchen work, but has potential for application to other branches of industry with short tasks in which dynamic work imposes load on various body parts.

The observers' educational background and experience must be taken into account when planning the contents and length of the training phase. Further development is needed for assessing loading of the hands. Well-defined criteria and well-recorded data have a positive effect on the ease of observation and the repeatability of the method. When the back, both shoulders, and hands are being assessed at the same time, the use of two cameras is recommended, even though not always practicable due to visual barriers at the workplace.

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APPENDIX

Rating of physical load on the low back, shoulders, and hands and wrists by posture and force requirements. The tables with body postures indicate the ratings: the principal posture is combined with the frequency and duration of its occurrence (a clock indicates a continuous action). Force requirements for the low back and shoulders were rated by the weight handled and corresponding force requirements. A descriptive scale was used for gripping.

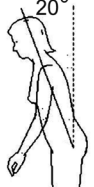
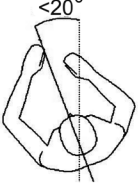
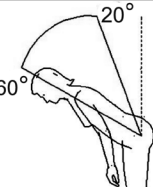
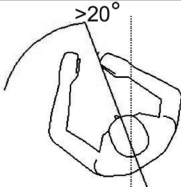
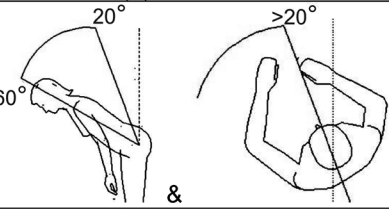
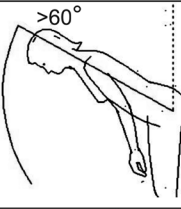
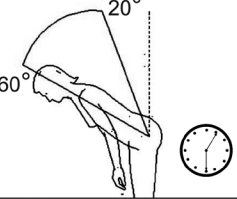
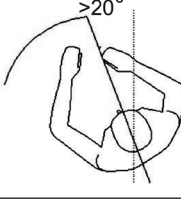
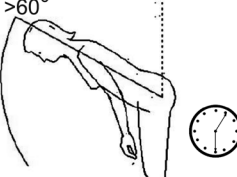
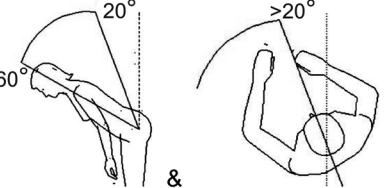

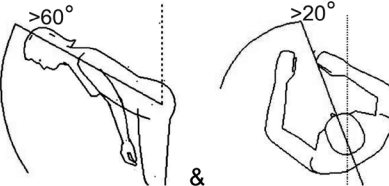

1	Back in neutral position or forward or laterally bent or twisted <20°		
2	Back occasionally forward bent 20°–60° or twisted or laterally bent >20°		
3	Back simultaneously occasionally forward bent 20°–60° and twisted >20° or occasionally bent >60°		
4	Back repetitively or continuously forward bent 20°–60° or twisted or laterally bent >20°		
5	Back repetitively or continuously forward bent >60°		
6	Back repetitively or continuously simultaneously forward bent 20°–60° and twisted or laterally bent >20°		
7	Back repetitively or continuously simultaneously bent >60° and at least occasionally twisted or laterally bent >20°		

Figure 5. The back. Notes. Force: 1—no load or load <1 kg; 2—≥1 kg, but <5 kg; 3—≥5 kg, but <10 kg; 4—≥10 kg, but <20 kg; 5—≥20 kg.

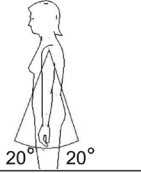
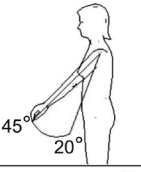
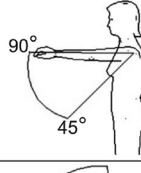
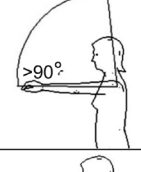
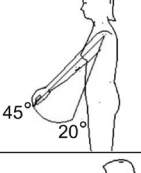
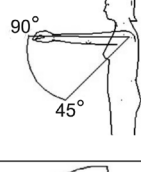
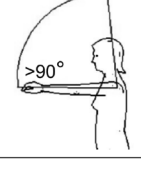
1	The angle between the trunk and the upper arm $<20^\circ$	
2	The angle between the trunk and the upper arm (forward or to the side) occasionally $\geq 20^\circ$, but $<45^\circ$	
3	The angle between the trunk and the upper arm (forward or to the side) occasionally $45^\circ-90^\circ$	
4	The angle between the trunk and the upper arm (forward or to the side) occasionally $>90^\circ$	
5	The angle between the trunk and the upper arm (forward or to the side) repetitively or continuously $\geq 20^\circ$, but $<45^\circ$	
6	The angle between the trunk and the upper arm (forward or to the side) repetitively or continuously $45^\circ-90^\circ$	
7	The angle between the trunk and the upper arm (forward or to the side) repetitively or continuously $>90^\circ$	

Figure 6. Shoulders. Notes. Force: 1—no load; 2— ≤ 0.5 kg; 3— >0.5 kg, but ≤ 4 kg; 4— >4 kg, but ≤ 10 kg; 5— >10 kg.





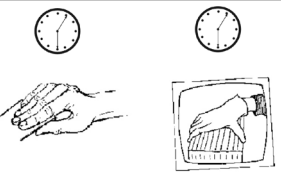
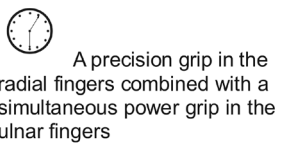
1	No grip or very light grip	E.g., baking rolls, generating pressure against a surface, pressing with the palm
2	Occasionally power grip	
3	Occasionally narrow grip or extensive grip	 
4	Occasionally double grip	A precision grip in the radial fingers combined with a simultaneous power grip in the ulnar fingers
5	Repetitively or continuously power grip	
6	Repetitively or continuously narrow grip or extensive grip	
7	Repetitively or continuously double grip	 A precision grip in the radial fingers combined with a simultaneous power grip in the ulnar fingers

Figure 7. Grip. Notes. Force: 1—light, 2—somewhat heavy, 3—heavy, 4—extremely heavy.