Ergonomics Research Techniques

Urmi Ravindra Salve

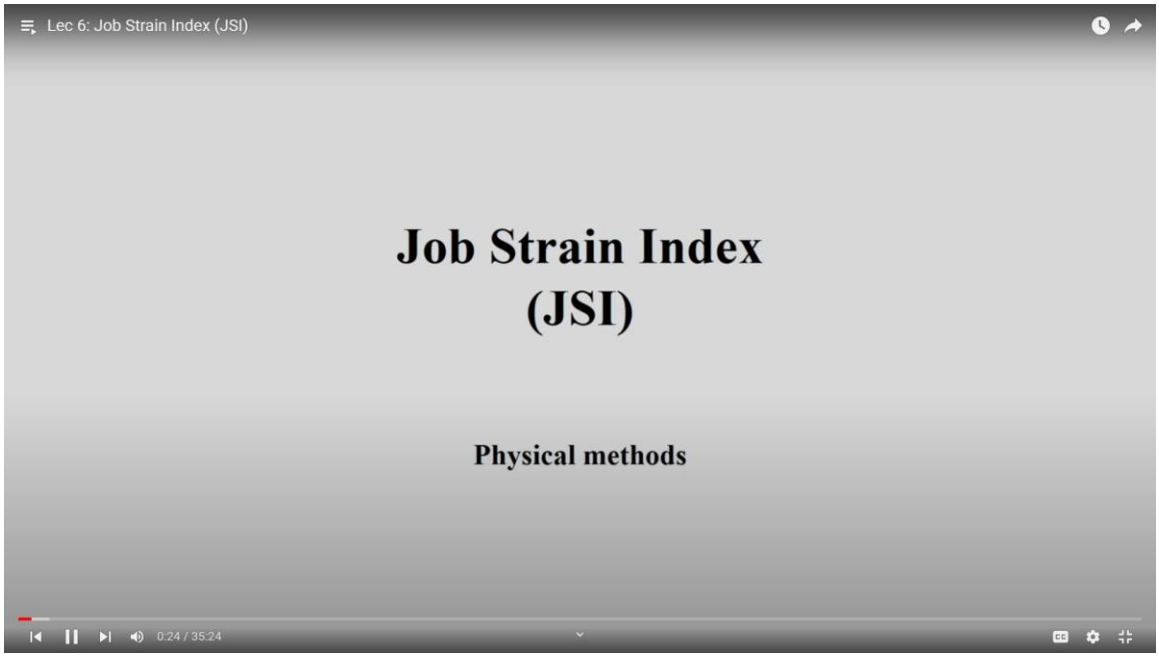
Department of Design

Indian Institute of Technology (IIT) Guwahati

Week – 02

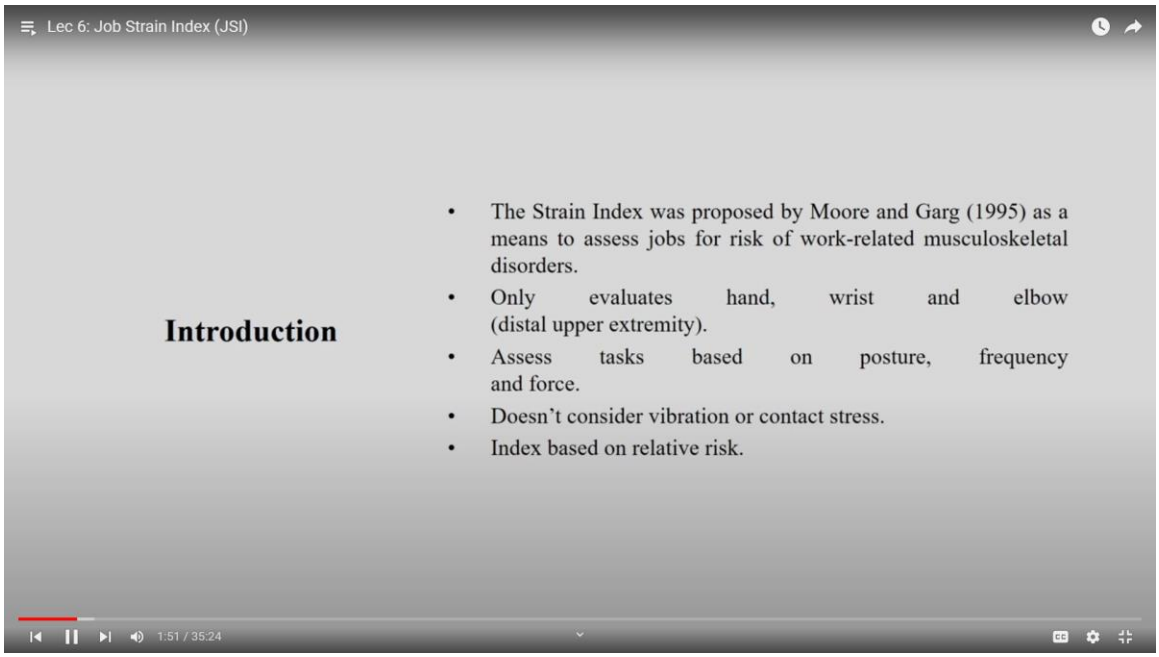
Lecture - 06

Lec 6: Job Strain Index (JSI)



Welcome back. Today, we will be talking about the Job Strain Index. JSI is a very useful tool when we talk about any activity that is repetitive in nature and involves your upper extremities. So, the job strain index is again a physical method. It helps the researchers understand the impact of the awkward posture, then repetition, forceful exertion, and varieties of things associated with such activities and how we can quantify them. So, you know, we will use this tool the same way we did with the earlier tools.

First, we will introduce ourselves, we will go over the procedure, then we will take it as an example, and then definitely discuss some advantages and disadvantages we will talk about. So, let us begin. This particular tool was introduced by Professor Mure and Garg in 1995. So, you can understand it is not a very old tool.



It is quite new when actually these physical methods or physical activities were very prominent in industries, right? So, right now, if you take the incidences for after the industrial revolution, most of the work is, you know, sedentary in nature, and a lot of cognitive aspects need to be considered, but at the initial stage of our ergonomics field evolution, that time we, lot of these researchers work for different kind of physical methods to identify or assess the load, physical load on the human body while working. Definitely, in many cases, these tools are context-specific. Here, the job strain index is also very much context-specific. So, this particular strain index was proposed by Professor Mure and Garg as a means to assess the job for risk of work-related musculoskeletal disorder.

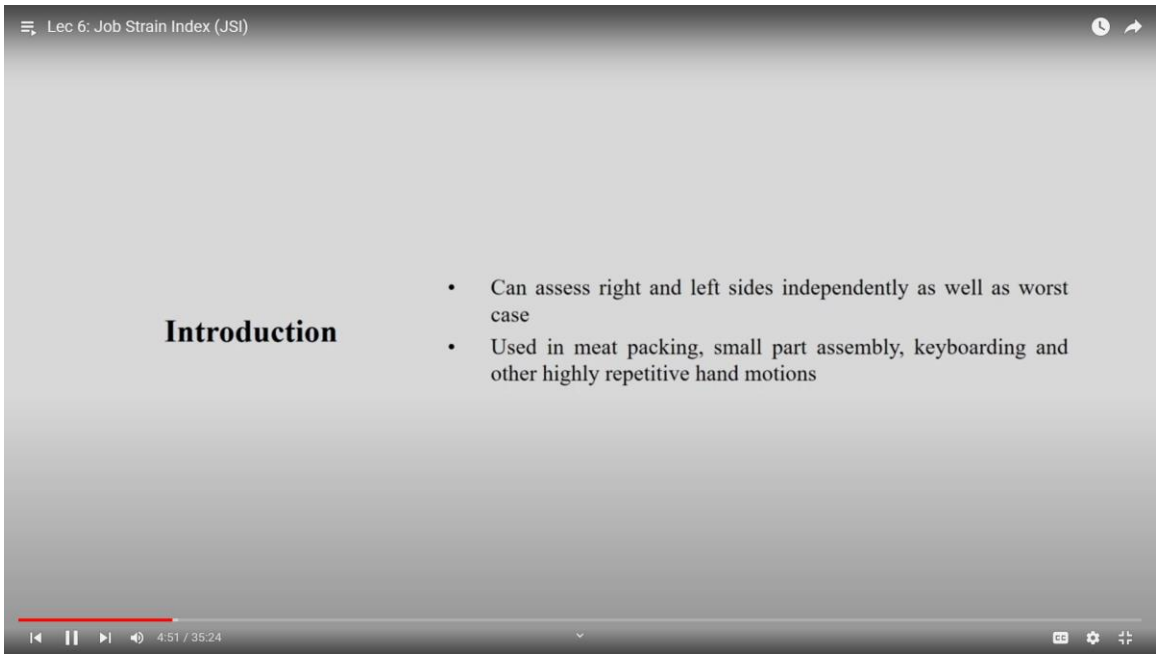
So, only it evaluates. So, before we take this tool as a measurement procedure for in our research or in our research activities, we should understand what it actually does. It only actually evaluates the hand, wrist, and elbow. So, we will talk about the distal upper extremities. So, from the elbow to this finger.

So, this is only what it is going to evaluate. So, if any job is associated with or is connected to the hand, wrist, and elbow, which involves, basically which involves the hand, wrist, and elbow like distal upper extremities, you can use this tool to assess or evaluate the strain index for that particular job. So, it assesses the task based on posture, frequency, and force. So, how does this particular tool actually work? It works based on the posture, posture adapted by the person, the frequency, and the force. It never considers the, you know, vibration, contact stress, or some other criteria or other stressors for musculoskeletal disorders.

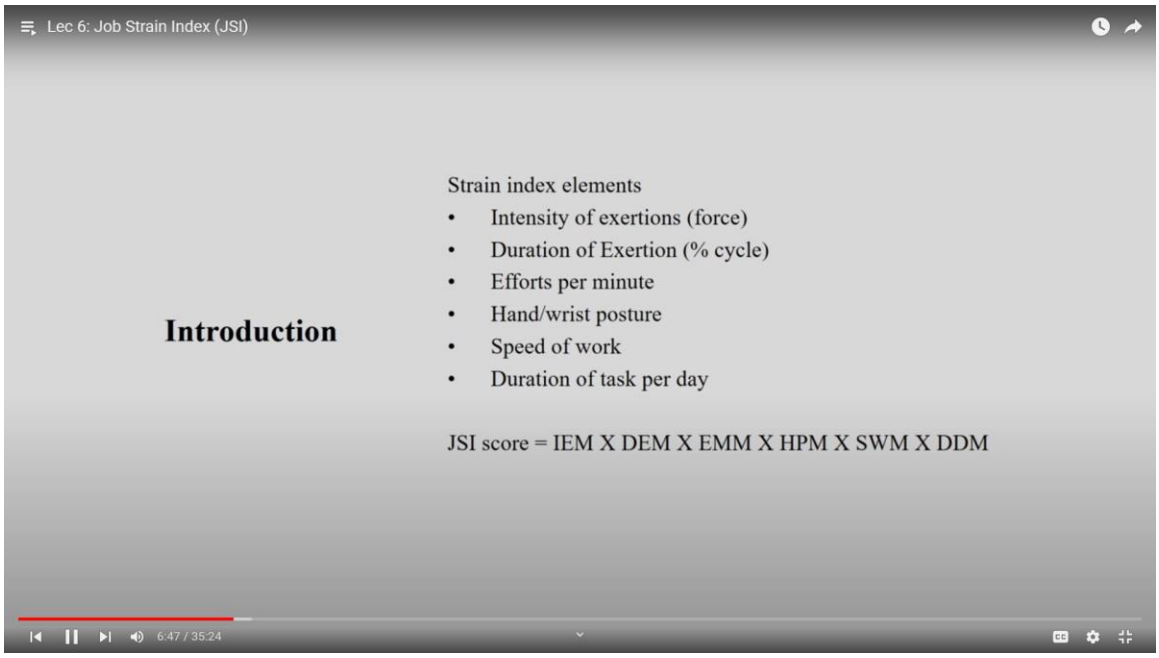
So, it only considered the posture, frequency, and force, not the vibration, and not the

contact stress. So, it is an index, and it is a relative risk. It is an index-based relative risk. So, let us go into a little more detail. It can assess the right and left sides independently, as well as the worst courses.

So, you are doing the analysis. Suppose both hands are similarly working; still, if you want, you can have the right analysis separately and the left analysis separately, or you can choose which part you would like to analyze. In many cases, as I mentioned for Rula and Reba and all those cases, that many cases what we do is take the dominant hand. We take the dominant hand for our analysis that also you can, or you can do both hands separately. So, just like at the initial stage when this particular tool came into existence, they identified that in the meat packaging industry, small part assembly, keyboarding, or any such activity that is similar to these, those cases, this particular tool is very useful.



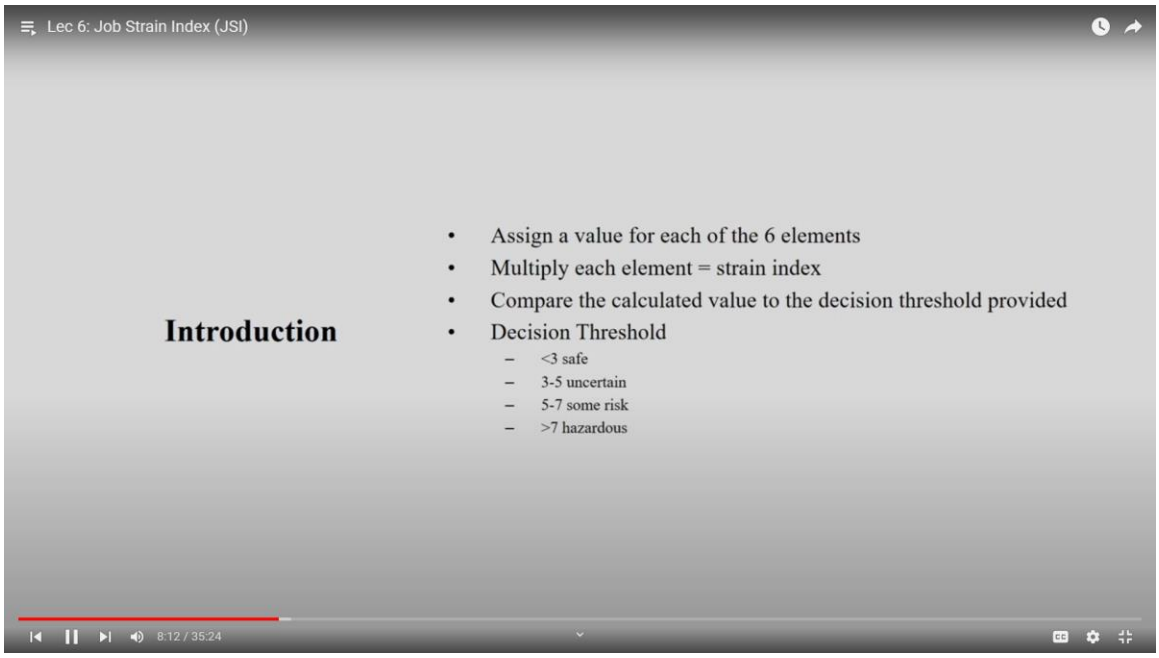
As I mentioned that you know, it is only useful when your distal upper extremity is involved in that particular job. So, for that job that requires rigorous involvement of the distal upper extremity for that cases, for those cases you can use the JSI or Job Strain Index. Before we go into more detail, let us understand what are the factors involved in this particular index calculation and what is the formula of it.



So, first, there are a total of 6 factors, ok, 6 elements, and an index element. First is the intensity of exertion, and second is the duration of exertion, that is, the percentage of the cycle, efforts per minute, and wrist posture.

So, it is not about the whole body. When we are talking about distal upper extremities, we will mainly be talking about the hand-wrist posture, speed of work, and duration of tasks per day. While calculating the Job Strain Index, we will come to know about one important terminology, which is the multiplier. What is that? There are some constant factors which we will come to know when we will go into more detail. So, each factor or each element that intensity of exertion will get converted through a pre-computed table into a multiplier through a rating from a rating to a multiplier.

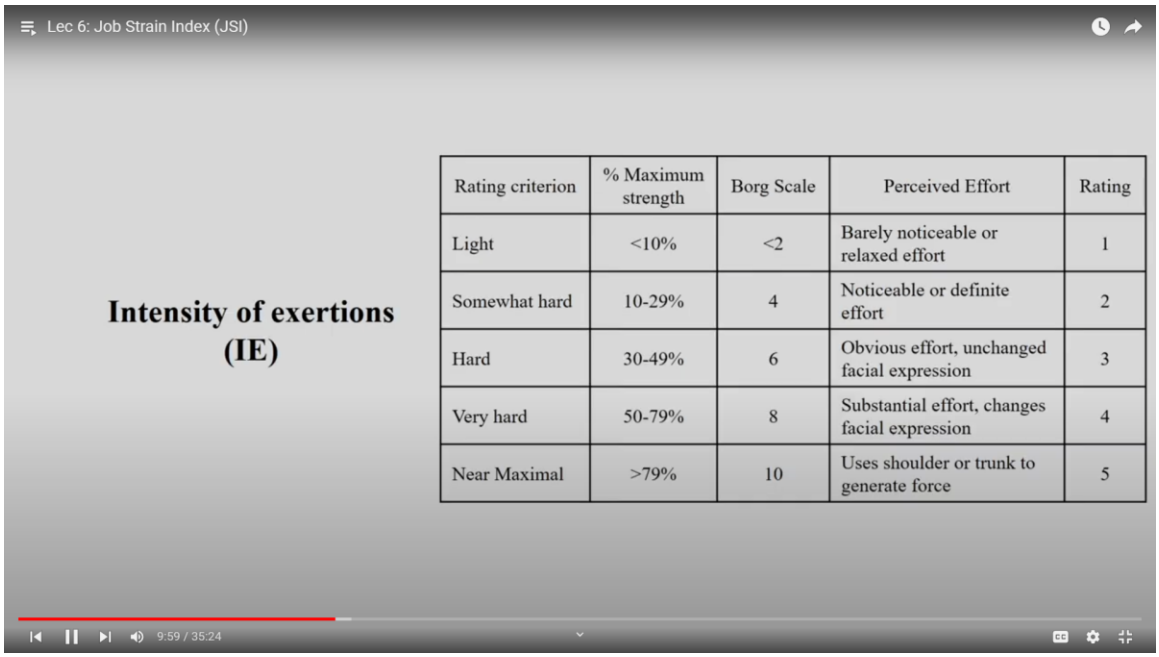
Once we multiply all these multipliers, all these six multipliers, we will get the score that is the index, ok, Job Strain Index, or we call it the JSI score. Then, we will compare that particular JSI score with the level as it is an index, so there will be some level. So, we will compare and we will say whether the job is hazardous or risky or whether it is going to have an impact in the future on the musculoskeletal system or not.



So, assign a value for each of these elements that is the mandatory portion; we will do how we can assign them. Multiply each element; then we will get the index and compare the calculated value with the decision threshold point.

So, if we get a value less than 3, we will say it is safe; the work is safe. If it is 3 to 5, then it is uncertain; maybe there are some unsafe activities present. So, you need to go for some kind of intervention or more investigation. 5 to 7, it is somewhat risks available, confirming yes, there is there are some risks, and more than 7 confirms yes, it is very hazardous. So, you need to look into that job, look into the construction, look into the procedure and you need to do some kind of intervention.

So, this is the scale that you will be using. So, in the end, whenever you are getting the JSI score by multiplying all these multipliers, this particular JSI score you will be comparing with this value. If it is less than 3, then it is safe; 3 to 5 is uncertain, 5 to 7 is somewhat risk, and more than 7, it is hazardous. Now let us begin: how can we understand and how can we score these 6 elements? First, we will go for intensity of exertion.



Rating criterion	% Maximum strength	Borg Scale	Perceived Effort	Rating
Light	<10%	<2	Barely noticeable or relaxed effort	1
Somewhat hard	10-29%	4	Noticeable or definite effort	2
Hard	30-49%	6	Obvious effort, unchanged facial expression	3
Very hard	50-79%	8	Substantial effort, changes facial expression	4
Near Maximal	>79%	10	Uses shoulder or trunk to generate force	5

So, the intensity of exertion, we can do the rating in 4 varieties in 4 different ways. In 4 different ways, we can do the rating for intensity of exertion. So this is the rating; you have 5 points, 1, 2, 3, 4, 5; these are the 5-point scale, so 5 ratings you can do. Now, how do we do? You can have a 5-point rating scale in which 1 means light, the intensity of exertion that is perceived by the person who is working over there is feeling light, 2 means somewhat hard, 3 hard, 4 very hard, and 5 depicts near maximal. So 1, 2, 3, 4, 5, right.

So this way, you can have a 5-point Likert scale, and you can use that. If this particular method is not useful for your scale, then you can go for some other way to rate the intensity of exertion. The next way is you need to calculate the percentage of maximum strength used by your upper distal extremity. How do you do that? So you can calculate your maximum voluntary contraction while in the posture of the particular work being done, and then you can have data from maybe different methods you can use, and you can calculate the what is the percentage of maximum strength being used while doing this particular job. So suppose you are tightening some screw in a particular job and you are trying to either identify the intensity of exertion of that particular job.

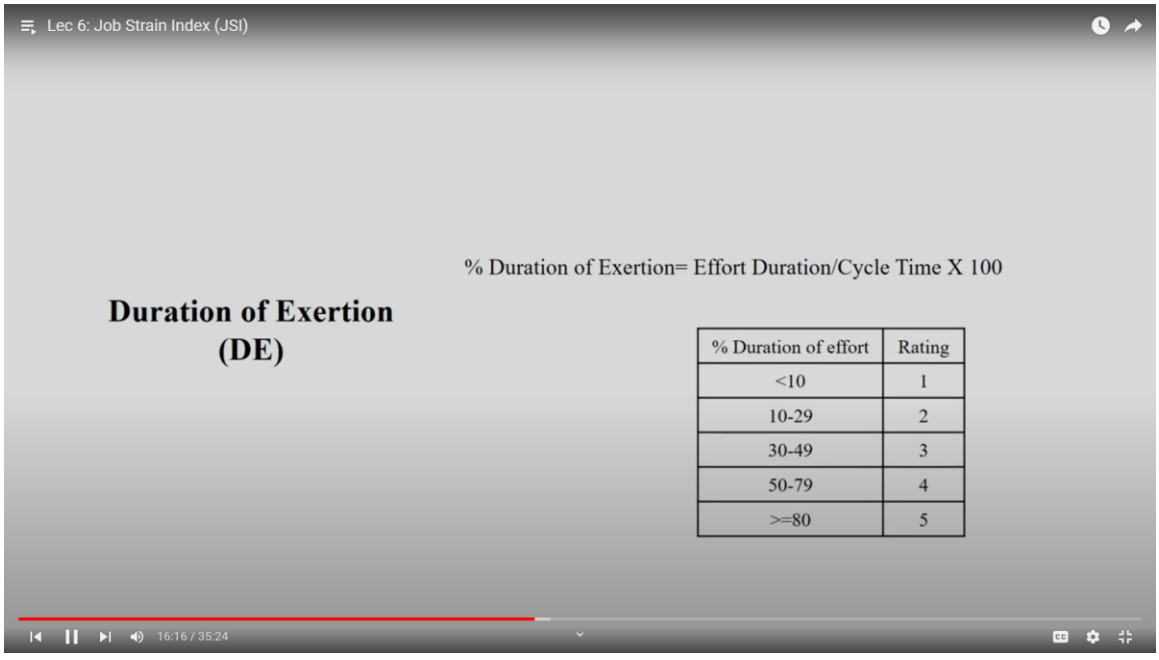
So what will we do in that particular activity, in that particular posture, in that particular manner,? What is the maximum possible voluntary strength that can be generated by those groups of muscles? First, you measure that, and you measure the working strength. Then you calculate what percentage is being used for maximum voluntary contraction while doing that particular job. So once you have the data, then you say if it is less than 10 percent, then it is 1, 10 to 29 percent, then it is 2, 30 to 49 percent, it is 3, 50 to 79 percent, 4 more than 79 percent, it is 5.

So this is another way. If it is also not possible for you to do so, then you can use Borg's CR 10 scale to get an understanding of the intensity of exertion in that particular job. So you know what the CR 10 scale looks like. I explained it earlier. In that, if any value is less than 2, it is 1. If between 2 to 4, it is 2, 4 to 6, it is 3, then 7, 8, it is, you know, 4 and more than 8 that is 10 and above near that location, it is 5.

So that you can determine the intensity of exertion using your Borg's CR 10 scale. The next way of doing this is how the person perceives that particular intensity of exertion. So this is more of the answer from the subject. So, how the person perceives it. So if he or she is perceiving barely noticeable, he cannot perceive.

So it is very light. So for that case, it is 1, noticeable or definite effort, then 2, obvious effort or unchanged facial expression. So it is connected to, so if you need a lot of effort to do, of course, your faces will, you know, facials muscles will work. So if you are doing some very tough job with your these muscles, automatically your facial muscles will react. So if it has an unchanged facial expression, but you can see the effort is there, then it is 3, substantial effort and changes the facial expression, then definitely it is more than that, then it is 4, and uses the shoulder or trunk to generate force. So it is not only happening with your distal upper extremity, you are taking effort from your shoulder and trunk muscle.

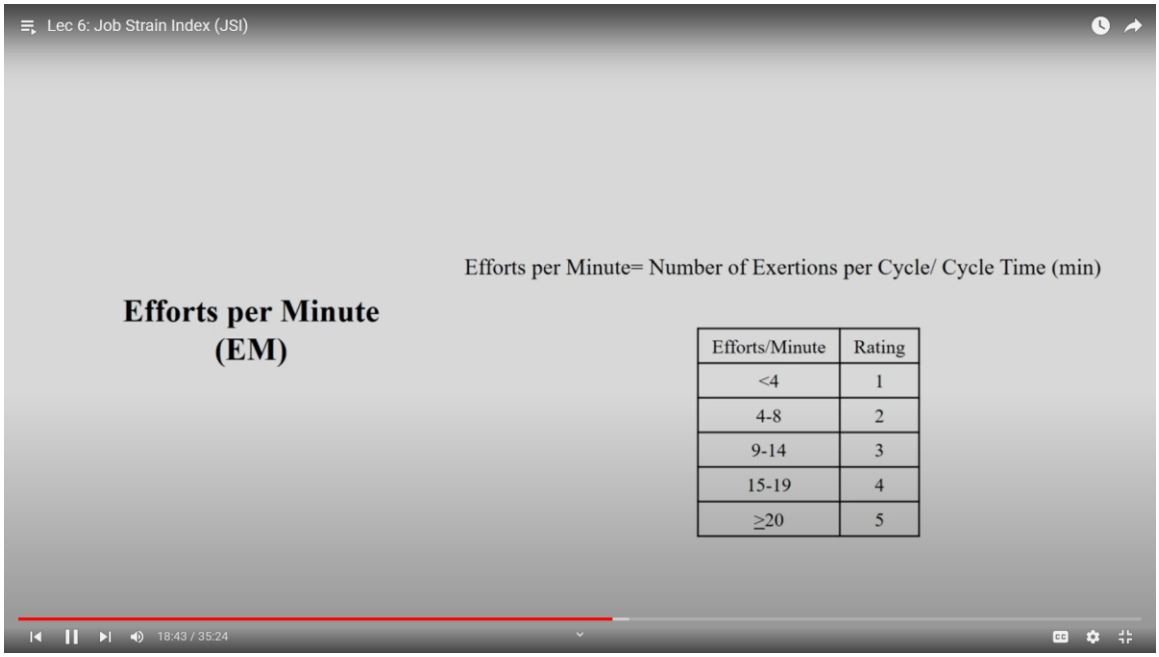
So a lot of activities are happening. So you know you can see the posture is changing. So, in those cases, you can give a rating of 5. So this is how we get the rating of the intensity of exertion, correct?



This is the first element of JSI. This is the first element of JSI. Moving to the next element, that is the duration of exertion. How do we calculate it? The calculation is the

percentage of the duration of exertion is equal to effort duration per cycle time multiplied by 100. So, in a whole thing, that particular effort is taking how long divided by the whole cycle time, okay, multiplied by 100. So if a particular job in a particular movement or a particular task, that particular effort is taking 3 seconds time and the whole cycle time is 10, then it is 3 divided by 10 multiplied by 100, fine.

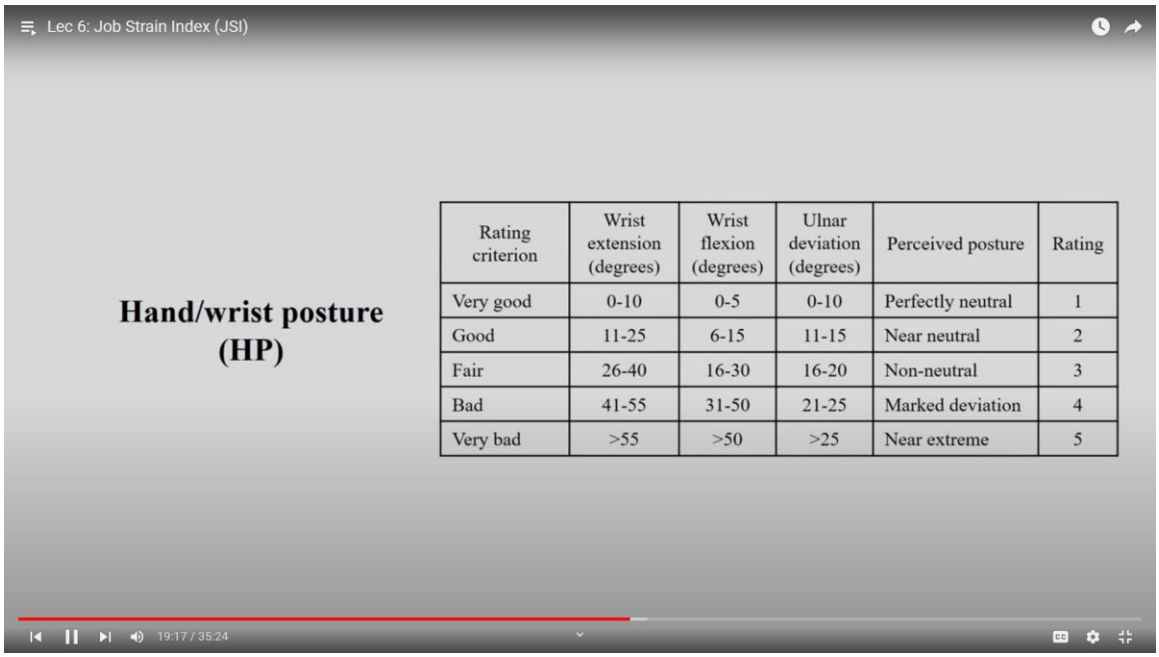
So this way, you can do the calculation of the percentage duration of exertion. So here you can see the value is 30. 30 means we are here, correct. So here also you can have a rating if it is less than 10 percent, then it is 1, 10 to 29, 2, 30 to 49, 3, 50 to 79, 4 and more than equal to or more than 80, then it is 5. So we can have the rating of duration of exertion.



Let us move to the third element. The third element is effort per minute. The earlier element was for that particular effort, how long you are taking in the whole cycle. Now, we are going to calculate in a minute how many times we are producing that or we are doing that particular effort. So, efforts per minute is equal to the number of exertions per cycle divided by cycle time. Everything you need to calculate per minute.

So if the number of efforts per minute is less than 4, then the rating is 1. The 4 to 8 rating is 2. the 9 to 14 rating is 3. the 15 to 19 rating is 4.

More than 20 rating is 5, very clear. So, till now, we have completed three elements. Now, let us go to the next element. The next element is hand-wrist posture. So here it is. We are talking about a distal upper extremity, right? So, whatever we are doing with our wrist, hand, wrist, and elbow.



Rating criterion	Wrist extension (degrees)	Wrist flexion (degrees)	Ulnar deviation (degrees)	Perceived posture	Rating
Very good	0-10	0-5	0-10	Perfectly neutral	1
Good	11-25	6-15	11-15	Near neutral	2
Fair	26-40	16-30	16-20	Non-neutral	3
Bad	41-55	31-50	21-25	Marked deviation	4
Very bad	>55	>50	>25	Near extreme	5

So now we will be talking about hand-wrist posture. There are, again, five ways that we can give the rating. You can use any one of them. You need not go for everything.

You can take any one of them, okay? The first one is rating criteria on a five-point scale; you can ask the person, or you can rate yourself if it is very good 1, good 2, fair 3, bad 4, very bad 5. Or you can have an angular measurement of deviation. What? This is an extension, flexion, and ulnar deviation. This also you can measure. So, suppose you are working in this particular posture.

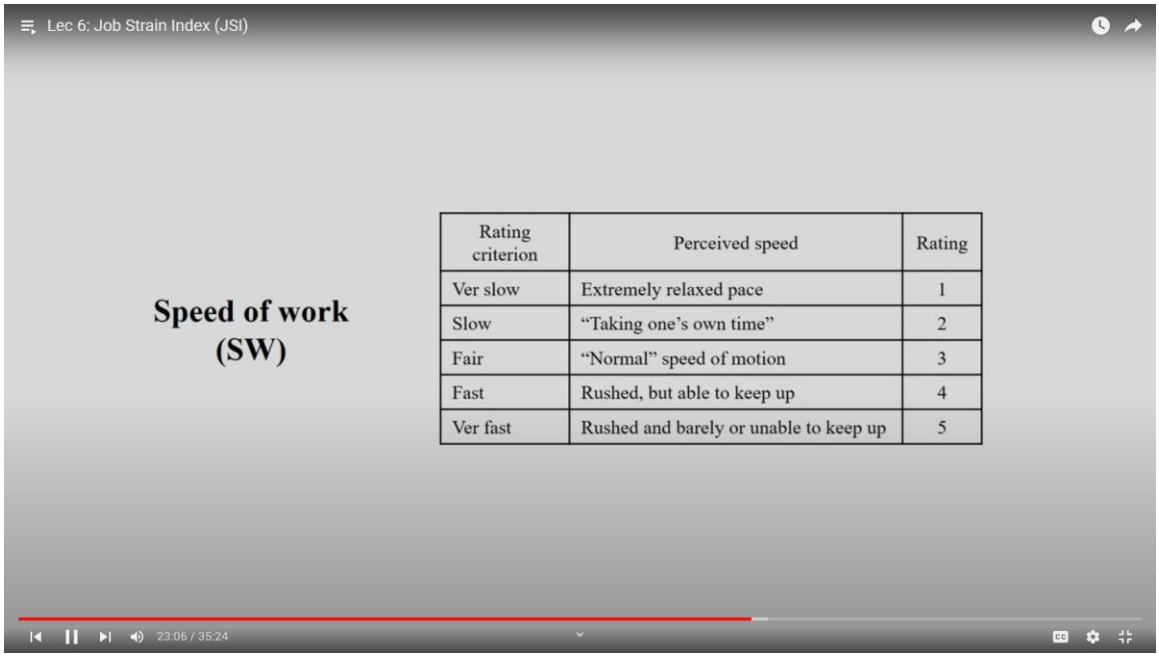
So you can measure the degree. To what degree is it being extended? It is in flexion. It is deviated. So anyone you can choose. You can see the degrees accordingly. It is mentioned what the rating is. So, for wrist extension, wrist flexion, and ulnar deviation.

Now, it may happen along with extension and flexion, and some ulnar deviation is present. In that case, you may ask a question about which value you should take. Here, as it is a risk assessment tool, you should always go for the higher value. For example, suppose in a particular wrist posture, your wrist is flexed at 16 to 15 degrees along with 16 to 20-degree ulnar deviation.

So if you take only flexion, the rating is 2. If you take only ulnar deviation, it is 3. As both things are present, you should go for a rating of 3, not 2. Why? If you take a rating of 3, then you are going to cover the maximum possible wrist present in that particular activity. So that is why you always need to go for the higher value.

Now this way you can collect. So here, maybe you can do a photographic method, or you

can use a goniometer or any other method where you can measure the wrist posture. Also, here, you can use your perceived posture and how you are perceiving that posture. So if you feel that it is perfectly neutral, then 1, near neutral, 2, non-neutral, 3, marked deviation 4 and near extreme, the deviation is near extreme, then it is 5. So these are the ways you define your hand-wrist posture for the job strain index.



Rating criterion	Perceived speed	Rating
Ver slow	Extremely relaxed pace	1
Slow	"Taking one's own time"	2
Fair	"Normal" speed of motion	3
Fast	Rushed, but able to keep up	4
Ver fast	Rushed and barely or unable to keep up	5

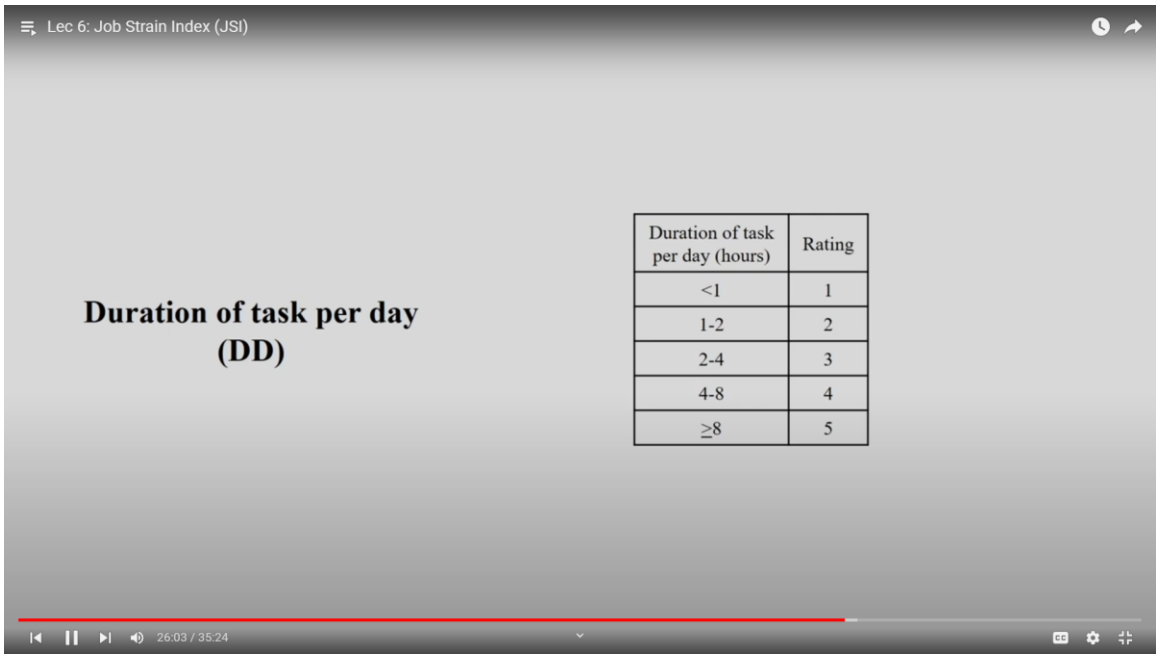
So you almost covered 4 elements. Now, let us move to the next element, which is the speed of work. Again, here we can do the rating in two varieties, two ways, okay? Five-point scale, very slow, 1, slow, 2, fair, 3, fast, 4, very fast, 5, fine. So that you can do it or give a perceived rating at an extremely relaxed pace.

So there is no hurry. Now, slowly, the person is working. There is no pace. It is very relaxed. Taking one's own time is not that very relaxed, but yes, he or she is completing the task on his or her own time. But it is doing; it is not that it is not happening; it is very, very slow.

It is done on time, okay. The normal speed of motion is rushed, but able to keep it up, okay, doing very hurry-bury, but it is not that something is missing. It is doing, but you can see the speed, and it is rushed and barely able to keep up the speed. So then it is 5.

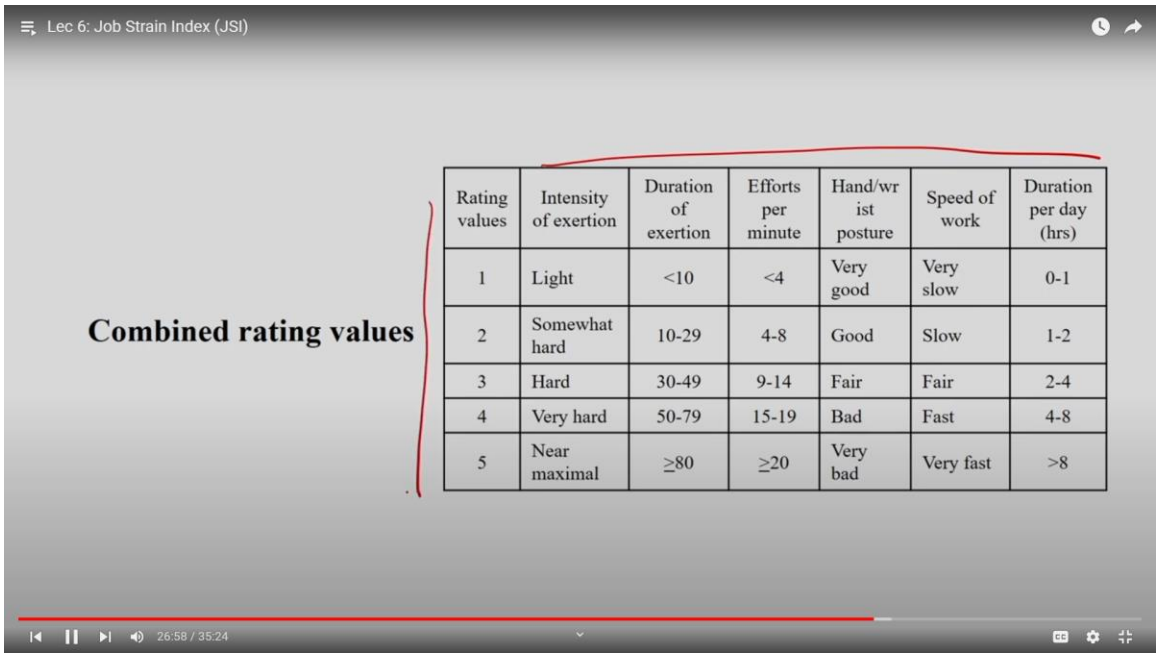
So this is perceived. Now, this always comes with experience. It is not that at the very beginning, once you start collecting data, you will be able to understand the discrimination between 1 and 2, then 3, 4, and 5. This is very difficult to understand. So, based on your experience and skill, you will develop it. So always here, we suggest having 2, 3, and 4 observers so that the best observation can pick it up. So if one observation is very different from others 2 and 3, you can again redo the task.

So this is always like for the learner, like for the person who is doing these things for the very first time or maybe at the very beginning of their research life, they take their peers' help to collect these data, not only for speed of work, for all other elements. Or once you have the video recording of the job, you do it at the laboratory many times, and you cross-check, okay, whether what you did earlier and what you do now match or not. So, biases, elimination of biases. So those things you will practice, and then it will go off, and you will have more accurate data.



So this is the speed of work. Moving to the next, that is the duration of tasks per day. This is very specific to how long they are doing the job, doing that particular task, or if it is less than 1, you can get this from their work schedule, right? So it is less than 1, then 1, 1 to 2, 2, 2 to 4, 3, 4 to 8, 4 and more than 8 hours, everything is in hours, okay. So, more than 8 hours, then it is 5.

Now you understand all the 6 elements of the job strain index. What we have done till now is just do the rating of each element. Now, here, we have to convert them into multipliers. So there is some pre-computed table. So this is how it looks like if you combine all the things.



Rating values	Intensity of exertion	Duration of exertion	Efforts per minute	Hand/wrist posture	Speed of work	Duration per day (hrs)
1	Light	<10	<4	Very good	Very slow	0-1
2	Somewhat hard	10-29	4-8	Good	Slow	1-2
3	Hard	30-49	9-14	Fair	Fair	2-4
4	Very hard	50-79	15-19	Bad	Fast	4-8
5	Near maximal	≥80	≥20	Very bad	Very fast	>8

Now, this is what the multipliers look like. This is the table where all the elements are placed along with the rating. Now, this is how the multipliers look like based on the rating. So, these all are multipliers of intensity of exertion. These are for the duration of exertion and so on.

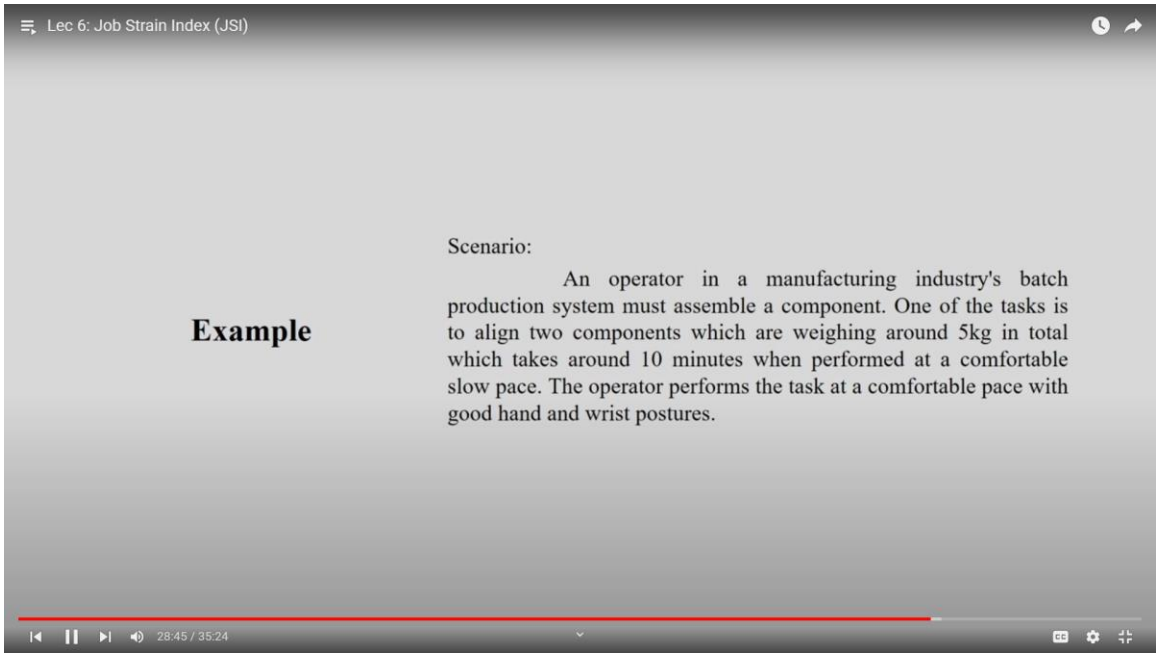
Multipliers for strain index

Rating values	Intensity of exertion Multiplier (IEM)	Duration of exertion Multiplier (DEM)	Efforts per minute Multiplier (EMM)	Hand/wrist posture Multiplier (HPM)	Speed of work Multiplier (SWM)	Duration per day Multiplier (DDM)
1	1	0.5	0.5	1.0	1.0	0.25
2	3	1.0	1.0	1.0	1.0	0.50
3	6	1.5	1.5	1.5	1.0	0.75
4	9	2.0	2.0	2.0	1.5	1.00
5	13	3.0	3.0	3.0	2.0	1.50

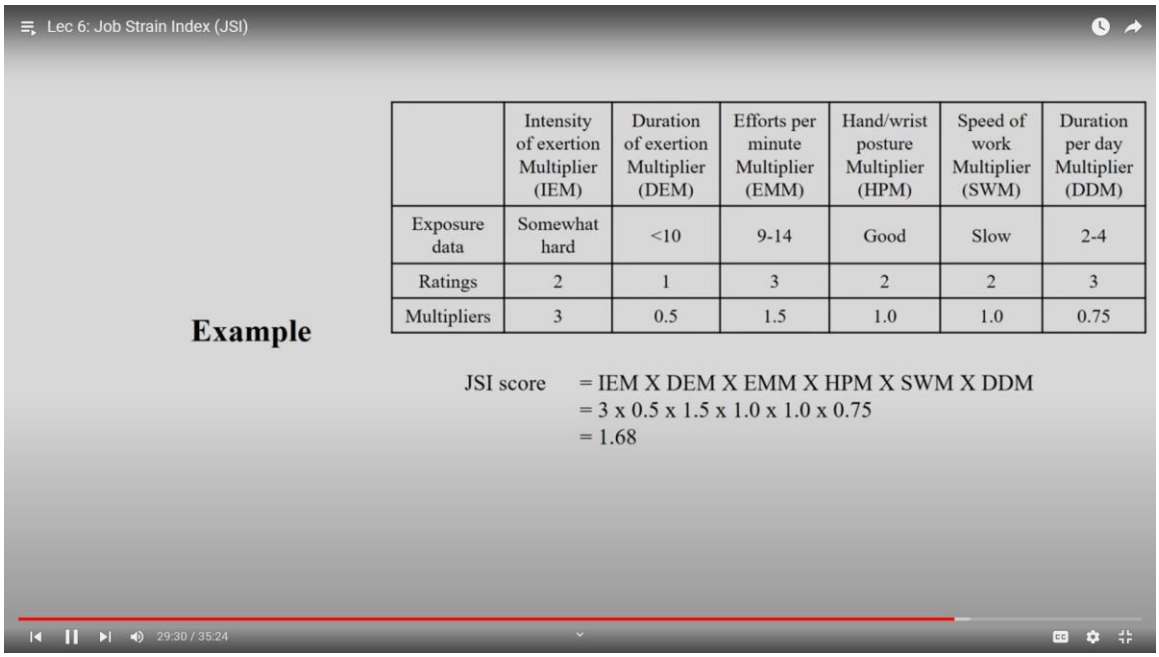
Now, just take one small example. Suppose I am picking these values; maybe from my experiment, these values are coming. So the intensity of exertion is 1, duration of exertion is 1, efforts per minute are 0.5, and maybe hand-bit posture is like 1.

5, maybe the speed of work is 1.5 and the duration per day is 0.7. So, what is your JSI? JSI is 1 multiplied by 1 multiplied by 0.

5x1.5x1.5 multiplied by 0.75. So calculate the value. Will this be your JSI score? Is it fine or clear? Now let us take a specific example, and then we will show how we interpret the result. So, I am explaining a scenario. An operator, first let me read it out, then we will take it further. So, an operator in the manufacturing industry's batch production system must assemble a component.



So the job is in a batch production system, and they have to assemble some components. One of the tasks is to align two components, which weigh around 5 kg in total, which takes around 10 minutes when performed at a comfortable slow pace. So here you are, getting an understanding of how things are being described. The operator performs the task at a comfortable pace with good hand and wrist posture. So this is the definition or description of the scenario.



Now, from this scenario, what we try to do is just an example. You can have your own example, and you can calculate. So what we did was we rated everything okay. So this is 2, this is 1, this is 3, this is 2, this is 2, and this again 3. So, accordingly, we got these multipliers from this pre-computed table.

From this pre-computed table, we got all these multipliers. And then, once we multiply, we get this value as 1.68; 1.68 is your JSI score.

Now, what do we do with this? Yes, let us move forward again with this value. So 1.68, of course, it is less than 3. So, the particular task or particular job that we are actually analyzing is safe. If, by chance, that particular JSI score supposed for a particular activity is 6.

2 for a case then it is here. So that means there is some risk. There is some risk in that particular job. So what are we supposed to do? We are supposed to enquire back why this particular score became high. And how do we do that? We look at the individual value; all 6 values are there, right? So we look at each individual value and check which value is causing the higher value of the total score than the JSI score. And if we see that there are some scores which are actually causing the higher value of the JSI, then through intervention, we try to modify it.

Once we modify it again, we cross-check whether it is reduced or not. If it is reduced, then yes, your intervention is successful. If it is not reduced, then your intervention is not successful, so you need to rework it. So this is how we use job strain index, and using job strain index, this is how we go for the intervention. Now let us talk about the advantages

and disadvantages. So, the advantage, if we talk about this particular tool, is that you know you get 6 elements in a particular job, and you see how these 6 elements are connected to develop or know how these elements are useful or influencing the development of musculoskeletal disorders.

So very easily, you can have some idea of where your intervention can start. This is one. Second it is a very easy method maybe after 1 or 2 training any person can adopt this particular method, and they can do the data collection as well as analysis. It does not take a lot of instruments, maybe a simple video recorder and pen and paper you can use. You can collect data and you can have the analysis.

So very, very useful. However, there are some disadvantages. There are some limitations. So, what are those limitations? The limitation is that it talks about only those cases where the distal upper extremity is involved. If any job requires whole-body involvement, this particular tool will not be able to assess the risk factors connected to musculoskeletal disorders. So for distal upper extremity, for those cases, only this tool is useful.

So, this is the limitation of this particular tool. This is quite a reliable tool. So I suggest if anyone is working in any occupation where the distal upper extremity is involved in doing some kind of assembly job, or repetitive job, then you can use this tool, you can implement this tool, and you can assess the risk factors which is related to the musculoskeletal disorders. That is all for today. So, if you have some questions, you can put them in the discussion box, and you can practice them while doing or practicing. If you have some difficulties also, you can inquire back. Thank you.