Ergonomic Risk Assessment of Students in Digital Learning

Zachariah C. Eldho and K. Muthukumar

1 Introduction

College and school education delivery systems have a problem due to the COVID-19 lockdown, and online education has taken off in a big way. To manage during the lockdown, schools have been holding real-time online classes and those students that do not have the required infrastructure are suffering. Some progressive schools were already using the flipped classroom where the lessons are made available to students online and the classroom time was used for discussion only. This is being done online quite effectively. With classes online, children have to spend as much time as possible on computers, tablets, and mobile phones. Students working from home find they are tired of it, and they are facing many health challenges. Health problems that are seen in those who sit for a long time are therefore common even in children. Old problems have got aggravated and new ones have appeared. Dry eyes, neck pain, backache, pain in the joints of the hands, inability to relax and sleep through the night are the most common health problems that can occur when sitting for long periods of time.

Risk identification and risk rating become a risk assessment component of the risk management process to determine the major risks faced by an organization, project, or strategy. The reason for risk assessment is to address the identified risk at the basic or current level [29]. This study intends to explore the ergonomic risk assessment of students in digital learning. Ergonomics concerned with understanding the relationship between humans, technology, and organization to create an environment tailored to a user's physical needs [12]. The advantage of using ergonomics is important to the industry also, so safety and health evaluation should be the initial stride in this

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task [8, 23]. The motive of ergonomic risk assessment is to recognize the current or potential risks that could lead to MSD's and also to obliterate work-related health risks. When pointing out dangerous parts, some effort should be made to lessen them. Risk assessments can be gainful in assessing interaction in the place of work [2]. Musculoskeletal disorders (MSD) are associated with inflammation and damage to ligaments, tendons, muscles, and peripheral nerves [21]. Work environment exposures can cause or exacerbate these musculoskeletal disorders, it is essential to identify ergonomic exposures in risk assessment. Intensity, frequency, and duration are the most important indicators of exposure, so it is essential to consider the risk for the development of MSDS [2]. To get over these problems, the sitting position of the students was investigated. The Rapid Upper Limb Assessment (RULA) method is one of several suitable work posture analyses.

The RULA method, introduced in 1993, evaluates the function of static muscles and the force applied to the upper extremities [22, 35]. This assessment method is mostly used to determine the load on the musculoskeletal system due to the posture of the neck, waist, upper extremities, muscle function, and excess weight on the body [20, 35]. By avail of RULA method, we can Perform a preparatory analysis to determine worker risk affected by factors of injury also include posture, static muscle contraction, and repetitive motion Style, determine employment preferences hinged on injury risk factor also compare the impact of work progress on evaluation before and after application [1, 36]. The risk assessment study was conducted on 15 students by observing the videos and photos taken. Different postures are selected and RULA scores are given to assess the risk level. Some economics tips are provided for those posters, which will help reduce the risk.

2 Materials and Methods

2.1 Literature Review

At present, most research activities in the field of education focus on e-learning and the risk associated with it. Let's go to various research journals full of research papers focusing on different aspects of e-learning, as well as ergonomic risk assessment of desktop, laptop, or mobile users. As the digital platform plays an important role in the education system, a study was conducted by reviewing forty-seven published studies and research on digital education and learning then provides some useful tips for those who want to develop online courses [32]. The effectiveness, efficiency, and satisfaction of the introduction of electronic technologies in education have been evaluated among students for two consecutive years by using the ergonomic card, which can identify positive trends in the field of e-learning according to the evaluation [19]. To know the effectiveness of online learning, a study says that 92% of all distance learning and online education, distance online education is better and more effectual than traditional education. Approximately 3% of studies have proven that the face

to face, traditional format is more effectual and showing about 4% mixed findings [28]. From the review of 38 documents, it is stated that e study has several benefits like learning from anywhere at any time, study without the same preconditions, speed and process studying for personal needs, collaborative learning saves time and expense along with personal study significantly, availability of fast results also learning with multimedia helps to conserve resources and reduce the environment and audio pollution [25]. Online learning can be interrupted when any five economic factors are unsatisfactory and the five ergonomic factors are physical, environmental, organizational, cognitive, and social ergonomic all of these are dominant factors in smoothening the student's online learning [34].

Different ergonomic studies take place in the school environment. A study was conducted by reducing school bag weight, correct poor seating in children, to reduce the musculoskeletal problems. The result shows some improvements in children and concluded that some ergonomic education program is effective in children to reduce musculoskeletal pain [6, 33]. Postural correction can also be done through exercise. There has been a significant reduction in neck pain and neck deformity in rural areas school-going children, proper correction was given through postural corrections and exercise [31]. Based on the Moyer projection phenomenon, it has been shown that prolonged seating leads to extensive lopsided trunk and scoliosis, as well as lumbar lordosis and kyphosis of the entire spine in school children [11]. To overcome the musculoskeletal problems faced by the students in school's researchers have suggested innovative and economical classroom chairs that meet all the basic needs of students in the classroom environment [2, 3].

Working on devices such as phones, tablets, laptops, and desktops can cause long-term physical problems for users. Using the RULA (Rapid Upper Limb Assessment) tool studies on the long-term use of smartphone users by collecting samples through videos, photographs, and also by providing musculoskeletal questionnaire, researchers mainly conduct the studies in school-aged children since they are mainly involved in it. The appearance of smartphone use among students is particularly vulnerable. In some studies, it is moderately dangerous while in others it is a high risk, the researchers point out that lying down posture is more dangerous than sitting posture [9, 24]. Risk assessment is done not only on smartphones but also on laptop users. Headache and back injuries are the most common symptoms correlated with the long-term usance of laptops and desktops [7].

2.2 Problem Description

Due to long-standing COVID-19 restrictions, students are reluctant to attend classes from home and face many health challenges. The old problems got worse and the new ones appeared. Common problems include dry eyes, neck pain, back pain, and inability to rest and sleep at night. Experts from many fields have a lot of advice on this subject. Tips from physiotherapists, gym instructors, yoga teachers, nutritionists, and psychotherapists are available online. Much of this advice is related to exercise,

yoga, meditation, following a proper routine, eating and drinking the right things, managing your responsibilities well, and sharing them. While all these recommendations make sense, one basic problem remains unaddressed—the kind of equipment one is using during learning. Most students use phones, tablets, laptops, and desktops while studying. Used improperly, this device can cause long-term physical problems for users. Frequent mobile phone use also creates new problems. Home furniture like sofas, dining chairs, dining tables, and coffee tables are not intended for continuous use. They also complicate issues related to phones, tablets, laptops, and desktop usage.

Students in everyday studies spend a lot of time on desktops and laptops without thinking about the impact on their bodies. Stretching the wrists, drooping, sitting without leg support, and poorly placed monitors can make it difficult for the body to recognize on a daily basis. These methods can lead to musculoskeletal disorders or stress injuries, which can greatly affect health, leading to pain, muscle fatigue, hypoesthesia, paraesthesia, and loss of performance. In one study, 20% of college students experienced musculoskeletal problems while working on a laptop and desktops. Students occasionally experience various musculoskeletal health problems like headache (20%), wrist and arm injury (35%), shoulder and arm injury (10%), neck discomfort (15%), backache (15%), eye strain (30%) after using the laptop and desktops, which is stated in a study [14]. There is a link between musculoskeletal disorders (MSD) and poor posture alignment. Studies show that a student with poor posture can develop a variety of musculoskeletal problems [14, 15]. Improper laptop use can lead to forwarding flexion of the neck and head, which can lead to certain biomechanical reactions and then to abnormal conditions like kyphosis [4, 14].

The mobile phone causes health problems even during normal times, but during the lockdown, phone calls are long and it is always in use. While the laptop is a problem only for those who use it, the phone creates postural problems for everyone. The user bends his / her neck to look at the phone. The ergonomic risk level of smartphone users is very high. Most smartphone usage levels are at 91.5% aeronautical risk [13]. One study found that musculoskeletal disorders were 90% more common in the neck, 73.30% in the shoulder, 63.30% in the upper back, 36.70% in the wrist and arm, and 30% in the lower back. Musculoskeletal disorders are rare, almost 13.30% in the hips and thighs, 13.30% in the knees, 10% in the ankles and feet, and 6.70% in the elbows [27]. Neck injuries from smartphone slump, a study found that the force on the neck increases as the human head jumps forward [5, 9]. There are several disadvantages to the long-term use of a smartphone. Tendonitis of the thumb and forefinger is a condition where injury, warmth, redness, swelling pain, and deterioration will occur to one or more tendons. In addition to these problems, it can also affect the grip of users' fingers, wrists, and thumbs [9, 10]. Carpal tunnel syndrome is a disease, examples of activities that involve repetitive and difficult hand movements, such as typing for messages or internet browsing using mobiles, can cause numbness, tingling, and weak grip [9, 30].

The chair and table need to work well together for optimal results. A poorly matched table and chair is the main cause of poor posture. Coffee tables cannot be

used for online learning with sofas or even while sitting on the floor. The anthropometric features of the users are essential for achieving various jobs that are safe and economical. If there are inconsistencies between human anthropometric data, tools, equipment, and furniture may cause this to decrease productivity, restlessness, accidents, biomechanical stresses, exhaustion, injuries, and cumulative impact. This is why a high percentage of students complain of neck and lower back pain as a result of health [26]. According to Mayo Clinic, Excessive seating deficiencies include obesity, high blood pressure, high blood sugar, body fat around the waist, and abnormal cholesterol—all of which can lead to metabolic syndrome. Overall sitting too much and sitting too long seems to increase the risk of death from heart disease and cancer. The seating includes not only the work area but also the dining table, sofa, and transport.

2.3 Methodology

An economist at the University of Nottingham in England, Lynn McTamney, and Professor E Nigel Colette was developed the Rapid Upper Limb Assessment (RULA) method. This is a posture sample device used to examine the risk associated with the neck, trunk, and upper eternities in individual workers. This tool uses a single page worksheet (Fig. 1) to assess the required body position, force, and repetition.

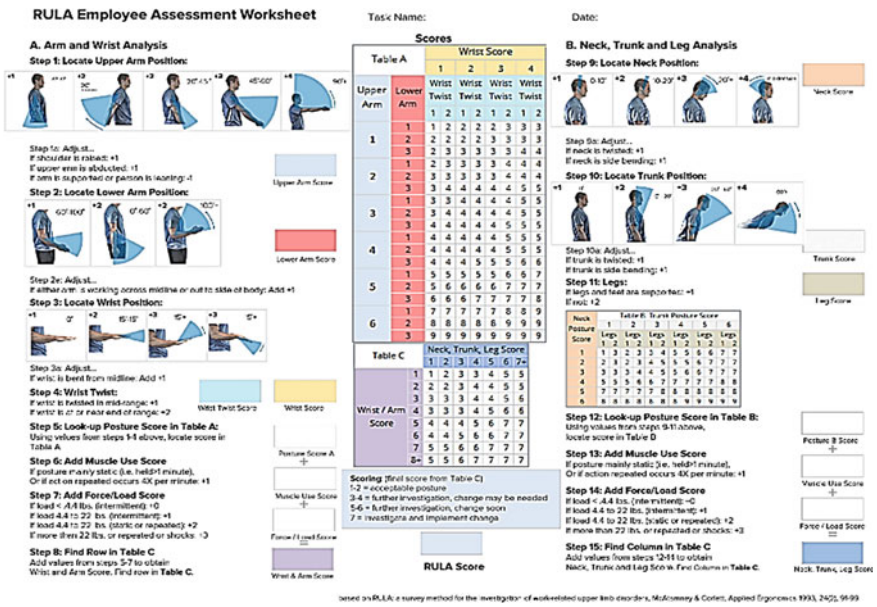

Fig. 1 Single page RULA worksheet (*Source* McAtamney & Corlett [22])

Score	Level of MSD Risk
1-2	neglibible risk, no action required
3-4	low risk, change may be needed
5-6	medium risk, further investigation, change soon
6+	very high risk, implement change now

Fig. 2 Score level of risk (*Source* McAtamney & Corlett [22])

Assessment scores are given for arm and wrist in A section and neck and trunk in B section [17]. Using this method there are three main steps for evaluating [18, 22].

Posture observation: Students sitting posture can be observed in different ways like direct observation, through videos, or by taking photos. The posture should be selected in such a way that the student posture is most repeated, which performs higher work tasks and the highest force load and those which are most harmful.

Giving scores: To evaluate postures, the angle between each part of the body and the vertical should be measured. While using the RULA method, we should consider only the upper limb not the lower limb but it will be considered to an extent. While working on it, load factors and muscle activity of that particular work also should be considered and the final RULA score will give to that posture.

Performance status: Appropriate action should be taken based on the RULA score. For understanding the level of risk RULA differentiates it into four levels [16] (Fig. 2).

The risk assessment study was conducted on 15 students by observing the videos and photos taken, from that 25 posters are evaluated. Students between the ages of 5 and 25 were selected for this study, especially those attending their classes on a digital platform in this pandemic situation. Other details like time interval, number of sections, etc., are given in the following Table 1. Out of 25 posture, a sample of 4 is mentioned below (Figs. 3, 4, 5 and 6).

3 Results and Discussions

This study evaluated students sitting in digital learning during this long-term COVID-19 restriction and to assess their risk level. Of the 25 participants, 5 were male and 10 were female, and those aged between 5 and 25 were evaluated for this study. Table 2 shows the RULA scores of four students out of the 25 students mentioned above, it contains all the details similar to the RULA worksheet. When handling devices such as mobiles and laptops, the force/load score is always zero because their weight

Table 1 Data's of participants

Number of subjects	Gender	Time/Section	Section/Day
1 (Fig. 3)	Male	1 h	2
2 (Fig. 4)	Female	1 h	3
3 (Fig. 5)	Male	1.5 h	3
4 (Fig. 6)	Female	2 h	3
5	Female	1 h	6
6	Male	1 h	3
7	Male	1 h	4
8	Female	1 h	3
9	Female	1 h	1
10	Female	2 h	1
11	Female	1 h	2
12	Female	3 h	1
13	Female	2 h	1
14	Female	2 h	1
15	Male	1 h	4

Fig. 3 Subject number 1

is less than 4.4 lbs., but this does not apply to 4 students with a laptop on the body which is mentioned in Table 3.

The consolidated rule score of 25 posers of 15 students is mentioned in Table 3. Out of 25 posture observed 11 posture have RULA score as 4, for 8 posture score as 5, for 4 posture score as 6, and its shown RULA score as 7 for 2 posture (Fig. 7). The results show that no student is in the right position, so the risk-free posture is 0%. 44% of postures show a low-risk, changes in those postures may be necessary and should be investigated in future. 48% of postures show a moderate-risk, which should be investigated and replaced as soon as possible. Those with a RULA score of 7 must implement the change, and 8% of the posture falls into this category (Fig. 8).

Out of fifteen participants observed, almost more than 50% of them fall under the high-risk category. Both male and female participants worked one to six hours

Fig. 4 Subject number 2

Fig. 5 Subject number 3

each day on their computer, laptop, and mobile on an average. The neck, trunk, and leg postures had a uniting effect on neck musculoskeletal disorder. In this case, it is essential that students and parents understand how to deal with the health problems caused by prolonged sitting also they should learn to sit properly and follow healthy rules. People who work from home and children who attend their online classes and who relax on their mobiles and tabs should definitely make the seat healthier, as improper sitting can cause neck discomfort, backache, shoulder, and knee injury. At home, students convert the space available to them into a classroom with limited

Fig. 6 Subject number 4

resources, while providing them with suitable seats and other facilities at the school. There is no other reason for health problems as the table and chairs are not made for long sitting activities.

The seat should conform to the natural curvature of the spine. Sitting upright is not good. The buttocks should rest on the back of the shore. The seat of the chair should be soft. Seating should be such that the body weight is shared equally on both sides. Leaning and tilting can cause back and lower back pain. Once a good office chair and table have become an important part of the home, provide children with a table and chair according to their height to sit in an online class. Proper cushioning should be provided for it. It is better to sit with a thin pillow on the curved part of the waist. Do not bend the shoulders forward or backward. The position of the shoulders when sitting should be the same as when standing.

When sitting in front of a computer, the height of the table and chair should be adjusted so that the neck is straight and the gaze is in the center of the computer. The table can be raised through some blocks and the computer can be raised with some books or boxes. Prolonged computer uses while sitting incorrectly can cause neck pain. Since computer and mobile use is common to all, it is important to exercise the neck for at least some time before the pain starts. Do neck exercises that strengthen the neck muscles. Students can also do a few light exercises to strengthen their muscles. The chin should not be close to the chest; the neck should bend forward

Table 2 RULA Scores of the students

Parameters	Subject 1 (Fig. 3)		Subject 2 (Fig. 4)		Subject 3 (Fig. 5)		Subject 4 (Fig. 6)	
	Right	Left	Right	Left	Right	Left	Right	Left
Upper arm position	4 (90° +)	4 − 1 = 3 (90° +)	2 (20–45°)	2 − 1 = 1 (20–45°)	3 − 1 = 2 (45–90°)	2 − 1 = 1 (20–45°)	1 − 1 = 0 (20°)	2 − 1 = 1 (20–45°)
Lower arm position	2 + 1 = 3 (100°+)	2 + 1 = 3 (100°+)	2 + 1 = 3 (100°)	2 + 1 = 3 (100°)	2 (100° +)	2 + 1 = 3 (100°+)	1 (60–100°)	1 + 1 = 2 (60–100°)
Wrist position	3 + 1 = 4 (15°+)	2 (15°)	3 + 1 = 4 (15°+)	3 (15°+)	2 + 1 = 3 (15°)	2 (15°)	2 + 1 = 3 (15°)	2 (15°)
Wrist twist	1		1		1		1	
Posture score (Table A)	6		5		4		3	
Muscle use score	0		0		0		0	
Force/Load score	0		0		0		0	
Wrist and arm score	6		5		4		3	
Neck position	4 (In extension)		3 (20°+)		2 + 1 = 3 (10–20°) (Side bending)		3 (20°+)	
Trunk position	3 (20–60°)		3 (20–60°)		2 (0–20°)		2 (0–20°)	
Legs	2 (Not supported)	2 (Not supported)	2 (Not supported)	2 (Not supported)	2 (Not supported)	2 (Not supported)	2 (Not supported)	2 (Not supported)
Posture score (Table B)	7		5		4		4	
Muscle use score	1		1		1		1	

(continued)

Table 2 (continued)

Parameters	Subject 1 (Fig. 3)		Subject 2 (Fig. 4)		Subject 3 (Fig. 5)		Subject 4 (Fig. 6)	
	Right	Left	Right	Left	Right	Left	Right	Left
Force/Load score	0		0		0		0	
Neck, trunk and leg score	8		6		5		5	
RULA score	7		7		5		4	
Level of MSD risk	Very high risk, implement change		Very high risk, implement change		Medium risk, future investigation, change soon		Low risk, future investigation, change may be needed	

Table 3 Consolidated RULA scores of the students

Number of subject		Posture score A	Force/Load score	Wrist and arm score	Posture score B	Force/Load score	Neck, trunk and leg score	RULA
Subject 1	Posture 1 (Fig. 3)	6	0	6	7	0	8	7
	Posture 2	4	0	4	5	0	6	6
Subject 2	Posture 1 (Fig. 4)	5	0	5	5	0	6	7
	Posture 2	4	0	4	4	0	5	5
Subject 3	Posture 1 (Fig. 5)	4	0	4	4	0	5	5
	Posture 2	3	0	3	5	0	6	5
Subject 4	Posture 1 (Fig. 6)	3	0	3	4	0	5	4
	Posture 2	3	0	3	3	0	4	4
Subject 5	Posture 1	3	0	3	3	1	5	4
	Posture 2	3	0	3	5	0	6	5
Subject 6	Posture 1	4	0	4	3	0	4	4
	Posture 2	4	0	4	5	0	6	6
Subject 7	Posture 1	4	0	4	4	0	5	5
	Posture 2	3	0	3	4	0	5	4
Subject 8	Posture 1	3	0	3	4	1	6	5
	Posture 2	4	0	4	6	0	7	6
Subject 9	Posture 1	3	0	3	4	0	5	4

(continued)

Table 3 (continued)

Number of subject		Posture score A	Force/Load score	Wrist and arm score	Posture score B	Force/Load score	Neck, trunk and leg score	RULA
	Posture 2	3	0	3	3	0	4	4
Subject 10	Posture 1	3	0	3	3	0	4	4
	Posture 2	3	0	3	5	0	6	5
Subject 11	Posture 1	3	0	3	3	0	4	4
Subject 12	Posture 1	3	0	3	5	1	7	6
Subject 13	Posture 1	3	0	3	3	1	5	4
Subject 14	Posture 1	2	0	2	5	0	6	5
Subject 15	Posture 1	2	0	2	3	0	4	4

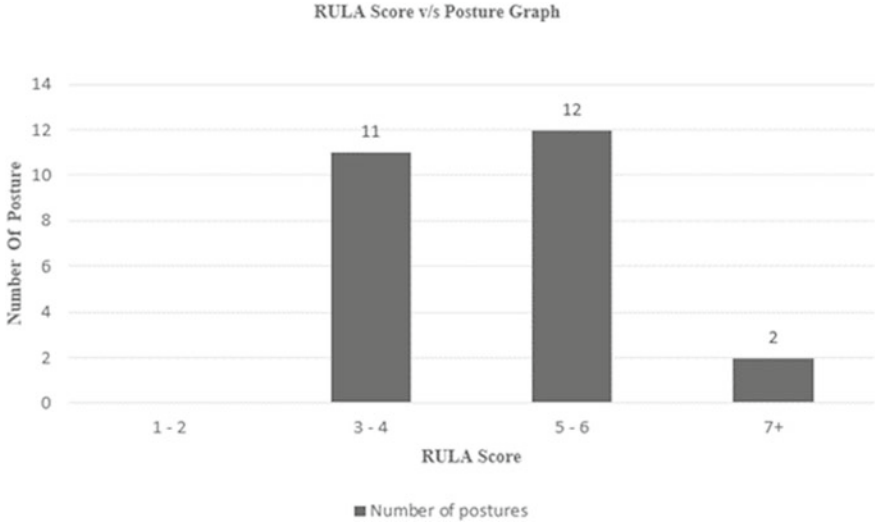

Fig. 7 RULA score v/s posture graph

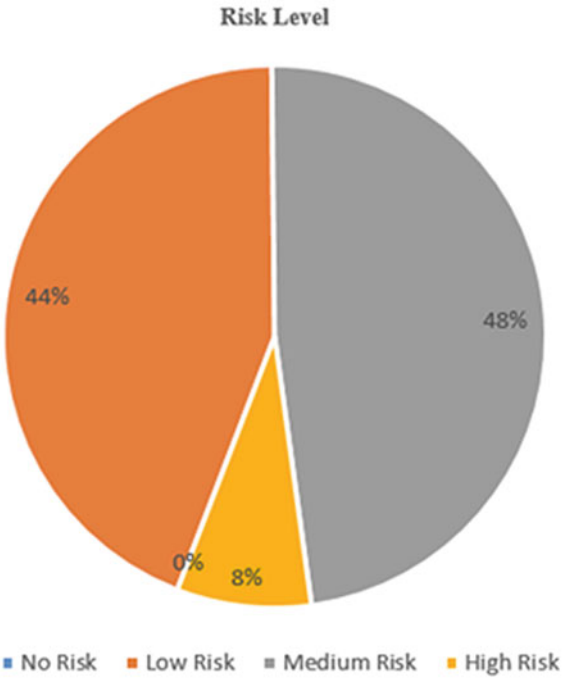

Fig. 8 The risk level of postures

in such a way. Bend alternately to either side by moving forward slightly. Now hold both hands together and clench the fists. The chin can be pressed into the fist for a while. No need to find a specific time for such exercises. This can only be done when sitting at regular intervals during the study.

In the best of circumstances, the laptop, whatever the brand, has an intrinsic ergonomic issue—it makes the user slouch. The keyboard and the display are too close to each other and one can optimize the height of the device either for the eyes or for the arms, but not for both. The display ought to be placed so that its top is level with your eyes. The keyboard should be an inch lower than your elbows. This should not be a problem if students are working on desktops or laptops in schools. Some experts say that the laptop can be used properly only when you lie down with a pillow for back support and place the laptop on your thighs, but it is hard to see the keyboard that way and even harder to use the mouse. Working in the bed creates many other problems as well. To get the right posture at work, it is necessary to lift the laptop display by 6–8 inches and use an external keyboard and mouse. Students can use a stack of books or a shoebox to raise the laptop and check the result instantly. Improper keyboard use can cause pain in the hands, knees, wrists, and fingers. Working on a desk with a keyboard and mouse can cause hand and knee pain. Those who type a lot should do short arm exercises every hour. Typing-mouse units on a laptop are on the same surface, which is not good for health at all. It is best to work with the keyboard and mouse attached.

Most students use their smartphone to attend their daily classes during this time, the mobile phone creates health issues even in normal times. The user bends his / her neck to look at the phone. The only way to use this device is to raise it to eye level so that the neck can be held straight while using the phone. One way to reduce phone usage is to get social media on computers. When sitting at a table, one can use easily available phone supports to keep the phone at the table. To help hold the phone up near eye level, students can use a selfie stick, with the bottom supported on the lap. Holds the phone up at a convenient level if they are sitting at a table.

Keep both legs firmly on the floor while sitting. Height-adjustable chairs are mandatory for those who sit for more than an hour in class. Even after adjusting the height the legs cannot be fixed to the ground, set a stand to place the legs so that the legs fall vertically from the knees. The knees should be raised straight or slightly. It is not good to lower the knees or stretch the legs forward or backward. Perform knee strengthening exercises before going to bed or getting up in the morning.

4 Conclusions

Most of the work of the new age can be done by sitting anywhere in the world. Since classes are online, children need to spend as much time as possible on computers, tablets, and mobile phones. Health problems that are seen in those who sit for a long time are therefore common even in children. Common health problems that can occur when sitting for long periods are neck pain, back pain, and pain in the joints of the hands. This study was conducted to dictate the severity of the risk in students studying on a digital platform in this contagious situation (COVID-19). A study was conducted on 15 students and 25 different sitting posters were evaluated during the study. For the study, Rapid Upper Limb Assessment (RULA), the most widely used monitoring method, is used to determine the risk in students. The results obtained after the study were unexpected. Of the 25 posture observed, not a single one appeared to be safe. About 44% of postures show a low-risk, 48% of postures show a moderate-risk, and 8% of them are showing a high risk. After assessing the risk, the students are given some economic tips which will help them to overcome the health problems they face during their studies, thus reducing the risk. This research may provide useful information for students who experience neck pain, back pain, or pain in the joints of the hands by the prolonged use of phone, tablet, laptop, and desktop during the study.

Researchers will be able to study these issues in detail as digital learning will last longer due to COVID-19 regulation, so the risk associated with digital learning is greatly increased if students use existing resources. A study can be conducted in designing new devices for holding laptops or mobiles. Designing efficient ergonomic chairs and tables for students while some of them are available in the market, the new design should overcome all the disadvantages of existing ergonomic chairs and tables. Since the high usage of mobile has much higher radiation problems than

computers and laptops, a new device can be introduced to replace the mobile. All you need to do when designing or developing a new thing is to make it affordable not only for the rich but also for the poor students.

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