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Ergonomic work from home and occupational health problems amid COVID-19

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Abstract.
BACKGROUND: The COVID-19 pandemic has displaced millions of people worldwide, forcing them to work from home offices in a situation of "new normal". Many home office workers were pushed to work in less than ideal settings in the pandemic situation. Work from home causes complications for employees related to their home workplaces lacking appropriate support from the employers.
OBJECTIVE: This article aims to analyse how pandemic has changed and affected workplace ergonomics. We addressed, amidst the pandemic, how work is being performed, the layout of the workplace, and its effects on an employee at home workplace.
METHODS: In this descriptive study, we used chain referral sampling to collect data from 273 home-based faculty members employed in the universities and HEIs of Pakistan. Finally, we used inferential statistics for our data analysis.
RESULTS: Results showed that employees faced problems because they had no prior training for setting up an ergonomically proper workspace. According to the results based on home-based ergonomic examinations, difficulties were associated with using laptops, desktop computers, and nonadjustable seats with no functionalities of flexibility and armrests.
CONCLUSIONS: It is vital to employ appropriate instruments and mechanisms, like risk assessment, feedback for the actions performed, and the deployment of adaptive measures (similar to the preventive system of management of occupational safety and health - OSH). These tools must be regularly utilised and/or modified as the scenario changes.

Keywords: Crisis management, Covid-19, ergonomics, human factors, OSH, stay at home

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1. Introduction

The COVID-19 pandemic has changed many home-based activities in general and work activities in particular. Due to the prevailing circumstances, the layout of our workplaces has dramatically changed. As soon as COVID-19 began in early 2020, it plunged the world into panic and a self-isolation state was applied to prevent its transmission or acquisition [1]. Eventually, various organisations including, educational institutes, business firms and others were closed and almost all of them, in hassle, went online [2]. Resultantly, pandamic transformed the overall work outlook by severely affecting the concept of office and workplaces; since last year, educational institutes, like other organizations are continually evolving their traditional workplaces across the globe.

Researchers have used the term "new normal" worldwide, including the World Health Organization [3]. New standard settings have changed the overall business outlook, which was replaced by home as a new office space. Web conferences have replaced in-person meetings; in-person educational venues have been replaced by online teaching modes and accessible assignments and lectures through internet [4, 5]. Previously, employees used to spend sufficient time physically on site, i.e., before the pandemic started. Similarly, a larger chunk of time used to be spent in office spaces. Contrastingly, the new normal work settings are not the same [6]. Although, we agree that social separation, limiting concentration of individuals within restricted spaces, and the formation of strict norms are the key factors to limit widespread transmission of pandemic, still, there is more to do for ensuring psychological health and well-being of employees in new normal workplaces, i.e., work from home.

Recent pandemic has also modified our workforce's production scale and the overall number of goods produced and used throughout their time at home [7–9], because people worked in non-conducive work environment. Examining various issues in home-working conditions amidst pandemic has been somewhat scarce; limited studies address occupational health issues in these circumstances [9]. The unprecedented COVID-19 scenario, unfortunately, provides an opportunity to study the associated health effects of changing normal working life from regular workplaces to work from home. Hence, considering the new normal settings, this study examines [1] in what way employers prepared employees to face the challenges of continuing tasks and duties from home-based work in light of the present pandemic crisis, [2] are the organisations ready to meet the furnishing requirements of employees in their home-based workplaces? [3] Do organizations adhere to and comply with the pre-set rules of work hours in the context of home-based workplaces? [4] Finally, how these things affect workplace ergonomics by considering impact of pandemic?

In the wake of COVID-19, the swift shutdown of businesses and economies forced employees to move immediately from workspace locations to home offices. In universities the faculty members needed to have their laptops and were also required to set up a formal table or desk at their homes to continue their work. Instead, while working at home, they used dining tables, chairs, monitors, and other make-shift desks that various family members use for multiple purposes (for example, kids use the same table for school work, adults use the same table for their work, and family members use the same table for dinner). If not handled properly and in absence of appropriate resources, the home-based work may not be ergonomically fine for workers, because it results in a rapid onset of body discomfort that could lead to more severe issues in the future [10, 11]. We argue that appropriate ergonomic workplaces were needed to help employees perform better from their home. Ergonomically adjusted (appropriate) workplace is based on CSA Z412 office ergonomics guidelines that include availability, fitness and appropriate use of various office resources and inventory. These also include standard time durations and postural requirements related to type and use of chair, computer, external mouse and keyboard, etc. [12] (for scoring details, CSA Z412 office ergonomics guidelines may be viewed).

Faculty members of universities were experiencing a period of crisis due to the COVID-19 spread

and given that, ergonomic interventions were needed for addressing such crises [13]. These interventions are related to the employees, work resources, equipments and overall workstations. Ergonomics is an area of study that tries to improve workplaces and helps individuals work conveniently and comfortably. It is concerned with machines needed by the employees, their jobs, and everything they utilise for completing their work [14]. Ergonomic interventions are essential because today's worker wants to work smarter not harder.

In ergonomic interventions, we design things for people/workers to reduce potential injuries and/or other physical ailments related to performing the work. So, in the current paper, we are dealing with ergonomic interventions for the following reasons; (1) Approriate ergonomic intervention, if employees follow it and apply it correctly, sustains workers' health, which boosts workplace morale, work relations and quality of production. In turn, doing so reduces the chances of musculoskeletal injuries. (2) Such intervention decreases costs for workplace safety and insurance (WSI), and also ensures employee well-being. Therefore, ergonomic intervention enhances sustainability and decreases the money spent on individual, i.e., business costs associated with lost time, WSI, etc.

Our research is based on ergonomic interventions, which involve implementing pre-existing measures [11, 15], before the onset of the crisis to overcome and mitigate the harmful impact of crises on employee health, while working from home. A preventive system of management for occupational safety and health (OSH) is required, in addition to general measures, to use relevant tools for risk assessment alongwith providing feedback for enhanced performance. These tools must be utilised regularly or modified as the scenario changes.

The purpose of this article is to detail predictors or key components that affect workers' behaviors in their home office. So, the study addresses various home working factors that cause behavioral changes. It aims to analyse how pandemic has changed and affected workplace ergonomics. We address in this article, amidst pandemic, how work is being performed, the layout of the workplace, and eventually problems an employee might face at home workplace. The current home offices of academic staff were reviewed [16, 17] for potential ergonomic difficulties as part of a quality improvement effort. The study logically associates the preventative ergonomic management system already known by OSH with the ergonomic management system of crises through a scientific research methodology. By doing so, the current study will add to the growing body of knowledge related to COVID-19 pandemic and its associated ergonomic hazards.

2. Ergonomic factors and musculoskeletal disorders

We usually use Occupational Safety and Health (OSH) measures to prevent risky, unprecedented, and unpredictable situations [18, 19]. We take two main approaches when dealing with an ergonomic intervention; one is the reactive approach, which looks at the ergonomics by considering the workstation (from work design perspective) after some physical disorder occurs or when musculoskeletal disorder has already occured [20, 21].

A better approach is a proactive approach that addresses the ergonomics of the workplace and the individual, before anything undesirable arises. This approach is preferred because it helps prevent injuries from happening to begin in the first place [11, 22]. In addition, it helps to reduce WSI costs, leads appropriate ergonomic intervention and helps setup an appropriate mechanism before occurance of unforseen situations. This way, appropriate ergonomic interventions through proactive approach prevent further problems from occurring in the first place.

We address various musculoskeletal disorders as these are overuse injuries and there are several risk factors at work involved in potentially acquiring musculoskeletal disorders:

1) Repetition: It occurs when worker performs the same type of movement multiple times or continuously [23]. The increasingly significant number of repetitions performed leads to increased physical exertion, leading to increased tissue damage and a potential increase in repetitive strain injuries. In addition, a more significant number of repetitions performed requires a tremendous amount of recovery time. So, the more force a person applies to the body through repetition, the more rest he/she needs to recover the body [24]. Similarly, repetition without breaks and rest intervals adversely affect the body [15].
2) Force applied or exerted on a person: There are mainly two forces: (1) external force applied to

the body from external sources. A good example is having to lift something from outside. Second, internal forces are applied to a body within its musculature. For instance, neck and shoulder strength are required to support the arms while working on a desktop computer or smartphone [22].

3) Awkward postures: These include any type of posture that deviates from neutral posture. Awkward postures lead to fatigue; they also lead to strength limitations due to minimal movements [25]. Neutral posture is acceptable as it positions the body with the least amount of stress. As stated above, anything that deviates from the normal or neutral posture would be considered awkward. Bending sideways, forward rotations, etc, tend to put more force and stress on the body's muscles, ligaments, and tendons and can negatively affect human body.
4) Static postures: A position of holding something for a more extended period. Static postures can decrease blood flow if a person holds something for a more extended period (body is held in static or near static posture). It can lead to early fatigue and requires blood flow, whereas, musculature does not receive the blood due to staying in one position. Awkward static posture is more worst than neutral posture. While in an awkward static posture, one can realise that it could put more pressure on one's body [21].
5) Contact stress: It is an external force placed on one's body and puts external stress on the body physically. For instance, if someone takes their finger into some rugged equipment and pushes it deep, it is an example of contact stress. Another example of contact stress is the stress put on the underside of one's leg from the body's weight sitting on the chair. It obstructs the blood supply and affects muscle areas and nerves [23].
6) Vibrations: They cause the body to move primarily based on its own. It occurs when external forces are applied on the body, leading to movement throughout the body or in some specific parts. For example, people feel vibrations from things like driving tractors, vehicles, etc. A vibration of small magnitude can lead to musculoskeletal injuries, and it can also lead towards problems in the lower back and upper back [10].
7) Extreme temperature: These are extreme hot or extreme cold temperatures. Extreme temperature, i.e., the cold, may affect muscles and causes tendons to become less flexible. As a result, a person's muscles do not work properly during such extreme weather, i.e., not at the same level as in normal temperature. Hence, extreme temperature decreases blood circulation in arms and hands, legs and feet during tough weather conditions.
8) Psychosocial factors: These include work-related stressors that affect workers in organisations. Stress arises due to increased job demands, low control, low perceived fairness, or lack of quality. Stress creates negative body responses [19, 26] which cause musculoskeletal disorders and physiological changes in the tissues. For instance, if workers have high work demands, it directly impact them because they are stressed. For example, an office clerk, who is stressed because of his job duties, may not perform smoothly and act violently in return. In the long run, such stress increases musculoskeletal activity and sensitivity to pain [15, 27].

Psychosocial issues are ergonomic issues that need to be addressed. Research shows that during COVID-19, the nature of psychosocial issues was different; for example, please see [10, 28]. In addition to the regular issues, workers who are bound to work with other people because their job requires interaction with others, may experience increasing fear for their health, co-workers' health, and health of their family members. Lack of personal protective equipment (PPE) or the requirement for personal protective equipment can also increase problems [29]. For instance, workers may face stress in COVID-19 if they have no protective shield, which eventually affects their well-being. Similarly, since last year, people have faced isolation that potentially increases their stress levels because of being away from performing any physical exercises and outdoor activities i.e., absence of facilities and exercise equipment due to no access to gym and other such resources [30]. Similarly, during pandemic, people could also not enjoy various types of recreational sports that they used to have previously during their normal routine, i.e., before pandemic. All such restrictions and unavailablility of resources increase an individual's stress level and add to the psychosocial stressors. The above-mentioned psychosocial stressors are uniquely associated with Covid-19 times and can cause musculoskeletal disorders [31]. Consequently, all the risk factors stated above can significantly

lead towards potential acquisition of musculoskeletal disorders.

Given the above detailed account of factors causing potential health disorders in existing circumstances, we argue that during Covid times the faculty of universities were in extreme choas and they were not prepared to work from home. Because everything happend in an unplanned and haphazard manner, universities had not done any homework related to the continuity of operations, there was no prior planning related to training, equiping and facilitating their workforce to continue working from home. Similarly, as universities had no earlier exposure to such a massive pandemic crises, they didn't have any resources to help people establish ergonomically fit workplaces at home; please see few recent studies, for example, [32, 33]. We further argue that employees experienced severe psychological stress due to increased work demands from their employers, resulting employees work for more than standard office hours while at home office. A recent large scale study published by harvard business review [34] has revealed key insights related to this issue. Heightened work pressures, larger expected number of work hours, all-time connectivity and quicker responsiveness caused work intensification during work-from-home period. We further insist that Covid-affected era has changed our earlier held perception of workstations because the growing new normal concept tends to shape our view of the worplaces from an entirely different lens. For now, we understand that if not totally work-from-home, it is going to be atleast a hybrid mode of doing work, i.e., partly from office (employer site) and partly from home.

In view of these arguments, it is emphasized that psychological health and wellbeing of the employees needs to be prioritized by applying suitable ergonomic intervensions for ensuring favourable outcomes for both employers and employees. Because ergonomics is a field that discusses interactions indicating relationship involving people and their conditions in which activities are carried out [35]. Ergonomic techniques aim to lessen a person's physical, mental, and psychological stress by adapting systems to meet their demands. Ergonomic efforts aim to improve the employee productivity, health, safety and well-being [29].

The prevailing Covid crises have increased the ergonomic risk exposure. The nature of vulnerability to ergonomic risk exposures is described as "occupational exposure to one or more of the following factors: forceful exertion, demanding posture, repetitive motion, hand-arm vibration, kneeling or squatting, lifting and climbing" [36]. Therefore, the purpose of applying ergonomic techniques is to minimize work load, and avoid its harmful impact on human health. Through positive impact on employee health, ergonomic steps also boost organizational performance as a result [22, 37].

We argue that workspace, at any location, should be designed and established by installing personal computers and other devices including all the required network devices [38]. The employee's ability to operate video display terminal (VDT), desk, chair, and dedicated office location in the house must be considered while designing the home workspace. A VDT operator is described as a person who employs a VDT for a portion of their workday. In addition, a VDT operator is elaborated as a person who utilises various tools for longer hours [39]. Long-term use of VDT has been linked to various disorders such as visual tiredness, tension, pain in the neck, lumbar, and dorsal pain disorder [40].

The ergonomic risk factors mentioned in the litrature have a significant impact on the eye [41]. It affects employees due to excessive periods of time spent infront of displays both at work and home. Inadequate lighting, unstable or defective display, poor combination of display with keyboard, and not taking proper work breaks, lead to visual fatigue [42]. Musculoskeletal disorders are also one of the possible consequences of these factors. According to the European Workplace Safety and Health Agency, the most prominent risk factors are repeated hand or arm motions- 65% and extended sitting postures-59% [43, 44].

When working with the VDT in a passive posture, many employees experience musculoskeletal disorders. Properly managing specific body movements, postures and facilitating a balanced use of body parts i.e., repetitive movements of hand, hand and finger in an effective manner are also influenced by organisation of the workspaces [45]. The wrong postures allow for the prolongation, excessive use or ultimately the musculoskeletal stress [46]. The workspace design deals with lighting, temperature, noise, vibration and radiation presence [47]. Saito et al. (1993) found that improperly positioned furniture and chairs, displays, keyboards, and peripherals contributed to cervical, dorsal, and lumbar development as well as shouldering pain, neck, arm and wrist pain.

According to the literature review, exposure to work ergonomic factors can result in osteoarthritis

and other musculoskeletal disorders. As a result, this research addresses: (1) how well prepared are workers for occupational activities from home? (2) Are organisations sufficiently equipped to provide furnishings demands of their personnel workspace at home offices? (3) Do organisations adhere to their working hours? Finally, (4) How does this affect workplace ergonomics and how has the pandemic changed those types of earlier held workplace ergonomics?

Recent exploratory work of [33] spotted light on the ergonomic considerations and associated risks in the context of teachers of public sector universities of Pakistan. The study stressed the importance of prior arrangements on the part of employers to avoid grievances of faculty members working from home workplaces; these could include, pre-planning, teacher orientation and training, and support to develop home-based workplaces. Similarly, [32] very recently conducted ergonomic assessment of university employees and concluded that many employees reported physical discomfort and musculoskeletal disorders resulting from ergonomically inappropriate workplaces at homes. The study recommended that organizational support could play important role for reducing potential occupational health risks [48]. Another recent qualitative study of a preliminary nature by [49], points out problems and risks associated with improper home-based workplaces; the study also suggests possible employer and government-led solutions for addressing issues related to the workplace ergonomics.

3. Materials and methods

3.1. Research context

Given the fact that ongoing pandemic is an unusual occurrence, and little is known about pandemic-driven ergonomic concerns in HEIs of Pakistan, the present study used a descriptive research method. It attempts to highlight work-ergonomic problems that require attention from various circles and related authorities. [50] stressed that descriptive research is one of the effective methods for describing the existing or ongoing phenomenon in the accurate possible manner. Similarly, [51] reported that descriptive study method is a sensible choice when research objectives are aimed at knowing characteristics of any population (i.e., percentage affected). It's well-designed to collect data related to describing the participants' demographic data, their satisfaction or dissatisfaction related to anything, event or occurrence. Further, as the focus of this study is workplace ergonomics and occupational health challenges amid COVID-19, we planned to carry out the investigation in an industry where operational and workplace disruptions severely affected employees' occupational health.

According to COVID assessment report published in the recent past by UNIDO (United Nations Industrial Development Organization), Pakistan's services industry is the hardest-hit by the pandemic. Similarly, Dawn (leading English newspaper) reported on June 4, 2021, that among services, education had a severe blow and in some cases, experienced permanent setback in Pakistan.

Beginning early 2020, pandemic caused extremely chaotic situation in universities/ higher education institutes (HEIs) of Pakistan because academic operations were at standstill and all the stakeholders, i.e., students, teachers, universities' administration and higher education, were in deep confusion. No one was prepared for the pandemic, neither mentally nor resource-wise. Later months paved the path for shifting classes/learning to the online mode, a so-called, rather a temporary solution to the problem. Unfortunately, online mode was not free from side effects because universities/HEIs could not address workplace ergonomic-related issues appropriately, which affected occupational health of the teachers in an unwelcome manner. In line with this, recent work of [49] pointed out that in the wake of pandemic, university teachers faced occupational stress due to various reasons, including no or minimal support for establishing home-based workplaces. These facts, including recent literature support, draw our attention to the importance of universities/HEIs as a potential pandemic-hit industry to study workplace ergonomics issues that emerged due to COVID.

3.2. Participants and procedure

We devised a survey instrument to collect data from primary sources in order to offer empirical support for achieving the objectives of studying ergonomics in the current study. The data came from surveys of faculty members employed in universities/higher education institutes (HEIs) of Pakistan. In the wake of COVID-19, HEIs had to shift their teaching from traditional to online mode and our study objectives were related to the context of shifting to that online mode. It was the first time for many faculty members

to employ online working methods and use sophisticated web tools for teaching, as desired by their institutions. Many faculty members lacked basic or minimum required facilities at home to transfer their academic operations to online mode in order to keep up with the times.

We approached the participants through our social network. Keeping in view the topic's sensitivity and minimizing chances of biases, we contacted them via chain referral approach. We insist that the chosen research approach is well-suited to nature of the study and its objectives. According to [52] chain referral sampling minimizes biases when the research topic is sensitive and poses security threats to the participants. This approach can work well when researchers undertake inquiries that involve unearthing mismanagement, malpractices or negligence on the part of authorities.

The survey related to 'official work activities at home' was created in google forms and the link was sent through emails. This research focused on faculty members working at seven HEIs in Sindh, Pakistan with over 600 faculty members in total. We distributed the survey to 480 faculty members, out of which 273 (i-e. 57%) responded to the questionnaires. Participants were briefed about the study objectives and they were asked to participate in the study freely.

Further, they were also briefed about voluntary nature of the study and that they can participate and withdraw at any time. The study's purpose was emphasised during data collection process, and confidentiality and anonymity of the responses were ensured. After being assured of privacy and anonymity, participants agreed to take part in the study. The survey instrument contained demographic information (e-g age, sex, and education) and information related to temporal ergonomics, ergonomics in the workplace, and health effects.

3.3. Measures

The survey was organised into (1) temporal ergonomics, (2) occupational ergonomics and (3) consequences on health. Based on the earlier literature, we have tried to adopt a holistic and comprehensive approach to measure ergonomics through three dimensions. We argue that adopting a three-dimensional approach will help investigate the research problem in more comprehensive manner. There were 17 items in total with multiple-choice response scales. We adapted the "Nordic Questionnaire" [53, 54], for home-based working populations, it is commonly employed in musculoskeletal symptomatology. According to [53], this ergonomics-related survey is an effective instrument to measure work-related musculoskeletal disorders (WMDs). The included questions were related to health consequences and the discomfort felt using furniture; it also included questions related to the environment in the working space during the last few weeks.

3.3.1. Temporal ergonomics

Temporal ergonomics: According to the "Introduction to Ergonomics" issued by World Health Organization, temporal conditions of the work are among workplace ergonomic concerns [55]. [56] highlighted the perceptions and subjectivity related to time with respect to ergonomics. Temporal ergonomics includes well-being of workers in terms of occupied hours during work, liable to the nature of job at home. It is aimed to address physical and mental exhaustion received at home-based workspaces. There are three facets of temporal ergonomics that are: (1) time on the job—this defines the level of participation, the amount of time each member spends working at a home-based office without supervisor's support, (2) time spent using ICT activities where a worker is wholly engaged with stakeholders via information technology, with a focus on the flow of accurate data to fulfil corporate goals, (3) working from home without the use of ICT- activities that are not related to work. These activities are harmful to the employee's well-being since the person is forced to work at home, with the added stress of accomplishing the assignment on time.

3.3.2. Ergonomics in the workplace

Occupational ergonomics or workplace ergonomics is our core focus in this study. Its importance is well-documented in the literature, for example, [49, 57, 58]. It considers environmental factors, i-e. Noise, lighting, temperature, the job location, the type of furniture used, and the length of time spent working in the workplace. It also considers a working area at home—a designated workspace in the home. Furthermore, ergonomics in the workspace is critical for the performance of activities, particularly when it comes to ease in the office. It includes workspace location in terms of natural light i-e. the placement of windows in the room space, allowing natural light inside the room. It must be designed to reduce workers' problems and increase lighting in the room. The sides must avoid

Table 1
The demographic data and its frequencies

Demographic categories	Frequency	Percent	
Sex	Male	146	53.5
	Female	127	46.5
Age	less than 25	9	3.3
	26–35	61	22.3
	36–45	118	43.2
	46–55	79	28.9
	56 and above	6	2.2
Marital status	Single	143	52.4
	Married	130	47.6
Employment duration	1–5 years	100	36.6
	6–10 years	91	33.3
	11–15 years	61	22.3
	16–20 years	21	7.7
Education	Bachelor's	97	35.5
	Master's	117	42.9
	Ph.D.	59	21.6

reflections of light that could harm an individual's ability to see when facing a display. In addition to that, workplace furniture must be appropriate for the work activity, leading to enhancing or at least sustaining their well-being and health. Broadly, appropriate ergonomics is associated with availability and suitability of above facilities and resources; whereas, their unavailability or poor quality may adversely affect the employees.

3.3.3. Health consequences

Health consequences may be musculoskeletal pains, like, neck, shoulder, lumbar back discomfort, arm–forearm, wrist–hand pain, and lower extremity pain; these are some of the symptoms. Bad or prolonged sedentary postures cause lumbar problems. Wrong placement and defects in the screen cause neck problems due to the screen location resulting in subsequent dizziness problems, headaches, and spinal problems [59]. Wrist and hand pain arise due to repetitive movements and cause difficulties to continue the work. Computers and other devices may lead to problems like carpal tunnel syndrome and tendonitis, including tendon inflammation in the thumb [60]. These can cause pain in forearm due to keyboard and mouse work. Shoulder distress and complaints can be linked to poor position caused by poor desks or poor positioning of the keyboard [61].

4. Data analysis and results

The findings of this research are presented in descriptive statistics and frequencies obtained for each category. Results are as follows from 273 valid workers' responses: 146 are male (54%), and 127 (46%) are female; 118 workers aged between 36 and 45 (43%); 130 (48%) workers are married; 35% of the workers have 6 to 10 years of experience, and 22% hold the PhD degree as their highest education. The demographic data of the sample are presented in Table 1.

Descriptive statistics show that workers have experience of working online after the pandemic, while 85% of them are working more than five hours per day to perform official duties (please see Table 2).

Descriptive statistics show that workers use various places in their homes to perform official duties. According to the data, 44% of workers use study

Table 2
The frequencies of employees working online at home

		Frequency	Percent	Valid Percent
How long have you been working online?	Less than two months	26	9	9
	From three to five months	33	12.09	12.09
	From six to eight months	56	20.51	20.51
	More than nine months	158	57.9	57.9
How many hours do you work online?	3 to 4 hours each	8	2.9	2.9
	4 to 5 hours each	34	12.5	12.5
	More than 5 hours per day	231	84.6	84.6
For activities that do not involve online working, how many hours do you spend on?	Less than three hours each	111	40.7	40.7
	3 to 4 hours each	63	23.1	23.1
	4 to 5 hours each	67	24.5	24.5
	More than 5 hours each	32	11.7	11.7

Table 3
The frequencies of factors related to workplace ergonomics at home

		Frequency	Percent	Valid Percent
What location of your home do you utilise to conduct online job activities?	Study	121	44.3	44.3
	Kitchen	4	1.5	1.5
	Dining	16	5.9	5.9
	Bedroom	69	25.3	25.3
	Courtyard or other home space	63	23.1	23.1
Is natural lighting designed for your workplace?	Behind you	46	16.8	16.8
	In front of you	48	17.6	17.6
	To the side	52	19.0	19.0
	Some combination of above	127	46.5	46.5
Do you have any of these problems in your home workspace?	There is far much noise	48	17.6	17.6
	Excessive or insufficient lighting	40	14.7	14.7
	Overheating or hypothermia	34	12.5	12.5
	Two or more problems	151	55.3	55.3
When it is possible to return to regular work, you want to?	Continue to work online	53	19.4	19.4
	Occasionally work online	96	35.2	35.2
	Not like work to online	124	45.4	45.4
Have you got mechanisms i-e. furniture to work online at home?	Yes	74	27.1	27.1
	No	72	26.4	26.4
	Some furniture	127	46.5	46.5
At the very least, does your office chair have an adjustable height and backrest, as well as five-wheel swivel base?	Yes	112	41.0	41.0
	No	161	59.0	59.0
For your online activities do you have, select multiple	Number of device(s) >1	25	9.2	9.2
	desktop computer	39	14.3	14.3
	Laptop	81	29.7	29.7
	Cellphone	93	34.1	34.1
	tablet pc	13	4.8	4.8
	only one device	22	8.1	8.1

room, 25% bedroom, 6% dining space, and 23% courtyard or other places in the home. There is natural lighting in their workplaces and 46% have some combination of lighting in their homes. At the same time, 55% were also facing noise and lighting issues or a combination of both in their home workplaces. Therefore, when we look at the data, they do not like to work online (45%) and have some furniture (46%) at home for their online working given the circumstances of COVID-19. Furthermore, (59%) of them have no office chair at home having an adjustable height and backrest, and (30%) have laptop (please see Table 3).

Homeworking has impacted workers immensely and has developed various disorders i.e., lumbar, shoulder, arm, hand, neck, soreness in lower extremities and wrist. We described it in Table 4. It shows the description of ailments concerning the home place used during working. Overall it resulted in lumbar discomfort (54%), neck (58%), hand (44%), arm or forearm (48%) soreness in lower extremities (47%) and shoulder (64%) when workers did their working from places in the home during the COVID-19 (please see Table 4).

Above data shows that all workers have faced various risk factors. It explains repetition, strength, posture etc., in their workplaces. These are three major risk factors for most of them and present in one or other form in everything or every type of work they do. At the same time, these factors lead to small risk of injury, however, the risk of injury increases if there are two or more factors involved in carrying out the work. While above risk factors concerning the health i-e. Stress vibrations, psychosocial, and temperature can potentially increase the risk factors for the workers. So through ergonomic interventions,

Table 4
The frequencies of physical effects and discomforts at home

		Frequency	Percent	Valid Percent
Have you had any back ache at the lumbar recently or remained several weeks?	No	26	9.5	9.5
	More often than not	42	15.4	15.4
	A little more than usual	56	20.5	20.5
	Much more than usual	149	54.6	54.6
Have you had any neck pain in the last several weeks?	No	19	7.0	7.0
	More often than not	28	10.3	10.3
	A little more than usual	67	24.5	24.5
	Much more than usual	159	58.2	58.2
Have you had any wrist or hand pain in the last few weeks?	No	16	5.9	5.9
	More often than not	55	20.1	20.1
	A little more than usual	82	30.0	30.0
	Much more than usual	120	44.0	44.0
Have you had pain in your arm or forearm in the last several weeks?	No	19	7.0	7.0
	More often than not	41	15.0	15.0
	A little more than usual	80	29.3	29.3
	Much more than usual	133	48.7	48.7
Have you had any shoulder pain in the last several weeks?	No	12	4.4	4.4
	More often than not	31	11.4	11.4
	A little more than usual	55	20.1	20.1
	Much more than usual	175	64.1	64.1
Have you had any soreness in your lower extremities in the last few weeks??	No	23	8.4	8.4
	More often than not	57	20.9	20.9
	A little more than usual	64	23.4	23.4
	Much more than usual	129	47.3	47.3

we attempt to reduce its effects, i-e musculoskeletal disorder, mainly caused by overuse.

We also used chi-square test of independence to see the association between variables. In addition, it is applied to test the relationship between two categorical variables. Moreover, it refers to whether the null hypothesis (i.e., independence) or alternative hypothesis (i.e., association) is referenced. Overall, null and alternative hypotheses for this test can be stated as: "Null hypothesis" there is no relationship between the two variables in the population and "Alternative (or research) hypothesis", there is a non-zero relationship between the two variables in the population. [i.e., within the population there is an association between the two variables].

The test involves testing whether the observed cell frequencies (or joint probabilities) in your data are significantly different from those that can be expected if there is no relationship (i.e., independence) between the variables within the population. When we reject the null hypothesis, we infer a relationship between variables in the population. The results of various variables are as follows.

For this analysis, we examined the relationship between "Gender" identification (coded 1 = male, 2 = female) and whether they have an interest in working online after the pandemic (coded 1 = continue to work online, 2 = occasionally work online, 3 = do does not like to work online). The count is the observed count in each cell. The expected count is the count that would be expected if there is no relationship between the two variables. The Pearson chi-square test indicates a significant relationship between gender and online working after the pandemic, Pearson's $\chi^2(1) = 57.704$, $p < 0.05$. It shows that males and females do not like to work online when the pandemic is over. Please see below Table 5.

For the relationship between "Age" identification (coded 1 = <25, 2 = 26–35, 3 = 36–45, 4 = 46-55, 5 = 56>) and whether they have an interest in working online after the pandemic (coded 1 = continue to work online, 2 = occasionally work online, 3 = do not

Table 5
The frequencies of discomforts concerning Gender at home

			Interest in working online concerning Gender			Total
			Continue to work online	Occasionally work online	Do not like to work online	
Gender	Male	Count	53_a	38_b	55_b	146
		Expected Count	28.3	51.3	66.3	146.0
		% within Gender	36.3%	26.0%	37.7%	100.0%
	Female	Count	0_a	58_b	69_b	127
		Expected Count	24.7	44.7	57.7	127.0
		% within Gender	0.0%	45.7%	54.3%	100.0%
Total		Count	53	96	124	273
		Expected Count	53.0	96.0	124.0	273.0
		% within Gender	19.4%	35.2%	45.4%	100.0%

Pearson Chi-square 57.704 $p < 0.05$. A,b represent respective total numbers for employees who worked from home.

Table 6
The frequencies of discomforts concerning Age at home

			Interest in working online concerning Age			Total
			Continue to work online	Occasionally work online	Do not like to work online	
Age	less than 25	Count	0_a	7_a	2_a	9
		Expected Count	1.7	3.2	4.1	9.0
		% within Age	0.0%	77.8%	22.2%	100.0%
	26–35	Count	9_a	18_a	34_a	61
		Expected Count	11.8	21.5	27.7	61.0
		% within Age	14.8%	29.5%	55.7%	100.0%
	36–45	Count	21_a	46_a	51_a	118
		Expected Count	22.9	41.5	53.6	118.0
		% within Age	17.8%	39.0%	43.2%	100.0%
	46–55	Count	22_a	21_b	$36_{a,b}$	79
		Expected Count	15.3	27.8	35.9	79.0
		% within Age	27.8%	26.6%	45.6%	100.0%
	56 and above	Count	1_a	4_a	1_a	6
		Expected Count	1.2	2.1	2.7	6.0
		% within Age	16.7%	66.7%	16.7%	100.0%
Total		Count	53	96	124	273
		Expected Count	53.0	96.0	124.0	273.0
		% within Age	19.4%	35.2%	45.4%	100.0%

Pearson Chi-square 18.260 $p < 0.05$. A,b represent respective total numbers for employees who worked from home.

like to work online). The count is the observed count in each cell. The expected count is the count that would be expected if there is no relationship between the two variables. The Pearson chi-square test indicates there is a significant relationship between age and online working after the pandemic, Pearson's $\chi^2(1) = 18.260$, $p < 0.05$. It shows that employees of different age groups are not interested in working online when the pandemic is over. Please see below Table 6.

For the relationship between "Age" identification (coded 1 = <25, 2 = 26–35, 3 = 36–45, 4 = 46–55, 5 = 56>) and Experiencing back pain (coded 1 = not at all, 2 = no more than usual, 3 = somewhat more than usual, 4 = much more than usual). The Pearson chi-square test indicates there is a significant relationship

Table 7
The frequencies of discomforts/back discomfort at the lumbar level concerning Age

			Experiencing back discomfort at the lumbar level concerning Age				Total
			No, not at all	No more than usual	Somewhat more than usual	Much more than usual	
Age	less than 25	Count	0_a	0_a	5_a	4_a	9
		Expected Count	.9	1.4	1.8	4.9	9.0
		% within Age	0.0%	0.0%	55.6%	44.4%	100.0%
	26–35	Count	1_a	14_b	17_b	$29_{a,b}$	61
		Expected Count	5.8	9.4	12.5	33.3	61.0
		% within Age	1.6%	23.0%	27.9%	47.5%	100.0%
	36–45	Count	15_a	$18_{a,b}$	15_b	$70_{a,b}$	118
		Expected Count	11.2	18.2	24.2	64.4	118.0
		% within Age	12.7%	15.3%	12.7%	59.3%	100.0%
	46–55	Count	9_a	10_a	16_a	44_a	79
		Expected Count	7.5	12.2	16.2	43.1	79.0
		% within Age	11.4%	12.7%	20.3%	55.7%	100.0%
	56 and above	Count	1_a	0_a	3_a	2_a	6
		Expected Count	.6	.9	1.2	3.3	6.0
		% within Age	16.7%	0.0%	50.0%	33.3%	100.0%
Total		Count	26	42	56	149	273
		Expected Count	26.0	42.0	56.0	149.0	273.0
		% within Age	9.5%	15.4%	20.5%	54.6%	100.0%

Pearson Chi-square 26.437 $p < 0.05$. A,b represent respective total numbers for employees who worked from home.

between age and experiencing back pain working online during pandemic, Pearson's $\chi^2(1) = 26.437$, $p < 0.05$. It shows that employees at various age groups experience back pain. Please see the below Table 7.

For the relationship between "Age" identification (coded 1 = <25, 2 = 26–35, 3 = 36–45, 4 = 46–55, 5 = 56>) and experiencing wrist or hand pain (coded 1 = not at all, 2 = no more than usual, 3 = somewhat more than usual, 4 = much more than usual). The Pearson chi-square test indicates there is a significant relationship between age and experiencing wrist pain working online during pandemic, Pearson's $\chi^2(1) = 28.309$, $p < 0.05$. It shows that employees at various age groups experience wrist or hand pain. Please see the below Table 8.

For the relationship between "Age" identification (coded 1 = <25, 2 = 26–35, 3 = 36–45, 4 = 46–55, 5 = 56>) and experiencing shoulder pain (coded 1 = not at all, 2 = no more than usual, 3 = somewhat more than usual, 4 = much more than usual). The Pearson chi-square test indicates there is a significant relationship between age and experiencing shoulder pain working online during pandemic, Pearson's $\chi^2(1) = 26.166$, $p < 0.05$. It shows that employees at various age groups experience shoulder pain. Please see the below Table 9.

5. Discussion and recommendations

COVID-19 has dramatically affected our personal and professional life. Earlier held general perceptions related to the office layout and work design have been challenged and replaced by new models allowing possibilities of doing offsite work during the recent pandemic crisis. So this study's aim was to explore how this dominant shift affects ergonomics of workplace at home? This study thoroughly addresses various risk factors and ergonomic interventions for higher productivity on the home-based work format of faculty members. At the same time, one of the objectives of ergonomic interventions is to work smarter but not harder for higher productivity. The beauty of ergonomic interventions is to match work with equipment and workstation for workers. The study's findings are consistent with earlier studies on the subject matter [40, 59, 60].

According to data analysis, more than 50 percent of the participants reported discomfort in various body

Table 8
The frequencies of discomforts/wrist and/or hand discomfort concerning Age

			Experiencing wrist and/or hand discomfort at the Age level				Total
			No, not at all	No more than usual	Somewhat more than usual	Much more than usual	
Age	less than 25	Count	0_a	0_a	3_a	6_a	9
		Expected Count	.5	1.8	2.7	4.0	9.0
		% within Age	0.0%	0.0%	33.3%	66.7%	100.0%
	26–35	Count	0_a	16_a	20_a	25_a	61
		Expected Count	3.6	12.3	18.3	26.8	61.0
		% within Age	0.0%	26.2%	32.8%	41.0%	100.0%
	36–45	Count	5_a	26_a	27_a	60_a	118
		Expected Count	6.9	23.8	35.4	51.9	118.0
		% within Age	4.2%	22.0%	22.9%	50.8%	100.0%
	46–55	Count	11_a	12_b	$28_{a,b}$	28_b	79
		Expected Count	4.6	15.9	23.7	34.7	79.0
		% within Age	13.9%	15.2%	35.4%	35.4%	100.0%
	56 and above	Count	0_a	1_a	4_a	1_a	6
		Expected Count	.4	1.2	1.8	2.6	6.0
		% within Age	0.0%	16.7%	66.7%	16.7%	100.0%
Total		Count	16	55	82	120	273
		Expected Count	16.0	55.0	82.0	120.0	273.0
		% within Age	5.9%	20.1%	30.0%	44.0%	100.0%

Pearson Chi-square 28.309 $p < 0.05$. A,b represent respective total numbers for employees who worked from home.

Table 9
The frequencies of shoulder discomfort concerning Age

			Experiencing shoulder discomfort at Age level				Total
			No, not at all	No more than usual	Somewhat more than usual	Much more than usual	
Age	less than 25	Count	0_a	0_a	0_a	9_a	9
		Expected Count	.4	1.0	1.8	5.8	9.0
		% within Age	0.0%	0.0%	0.0%	100.0%	100.0%
	26–35	Count	0_a	4_a	20_a	37_a	61
		Expected Count	2.7	6.9	12.3	39.1	61.0
		% within Age	0.0%	6.6%	32.8%	60.7%	100.0%
	36–45	Count	3_a	15_a	22_a	78_a	118
		Expected Count	5.2	13.4	23.8	75.6	118.0
		% within Age	2.5%	12.7%	18.6%	66.1%	100.0%
	46–55	Count	9_a	$11_{a,b}$	12_b	47_b	79
		Expected Count	3.5	9.0	15.9	50.6	79.0
		% within Age	11.4%	13.9%	15.2%	59.5%	100.0%
	56 and above	Count	0_a	1_a	1_a	4_a	6
		Expected Count	.3	.7	1.2	3.8	6.0
		% within Age	0.0%	16.7%	16.7%	66.7%	100.0%
Total		Count	12	31	55	175	273
		Expected Count	12.0	31.0	55.0	175.0	273.0
		% within Age	4.4%	11.4%	20.1%	64.1%	100.0%

Pearson Chi-square 26.166 $p < 0.05$. A,b represent respective total numbers for employees who worked from home.

parts during work from home office. It includes discomfort in the eyes, neck pain, headache, issues in the upper back, and lower back discomforts. On the other hand, if the data related to new normal office settings is compared with earlier obtained data, 80 percent of the same educational staff responded they had minimum discomfort in the traditional workplace before pandemic [62]. The new normal state and shifting to the home office during pandemics have resulted in a significant rise in disorders and discomfort. The transition from physical work to online (from home) might likely explain the increase in ergonomic symptoms. It is due to the widespread usage of computers and related devices-one of the most prevalent office issues. Previous research has demonstrated that laptop use in lesser quality workspaces causes uncomfortable position for wrists and it causes postures during typing or using the touchpad, i.e, arms that are not having any support put added stress on the upper back, and neck that is bent to gaze looking at the display [62, 63]. Further, majority of the faculty members do not have proper workplace at home, resulting in ergonomic concerns during work.

Musculoskeletal disorders and related hazards adversely affect employee health and it leads them to lower performance. We investigated musculoskeletal disorders in this study as these are overuse injuries and there are several risk factors at home-based work that cause musculoskeletal disorders. We found in our survey that during home-based work, the repetition of same type of work activities and associated movement of body parts lead to health-related problems [23]. The more significant number of repetitions performed leads to increased physical exertion, leading to increased tissue damage and potential increase in repetitive strain injuries [40, 59, 62]. In addition, a greater number of repetitions at home-based work required a tremendous amount of recovery time. So, the more force a person applies to the body through repetition, the more rest he/she needs to recover the body [24].

According to previous studies, there are substantial links between laptop use and good workplace conditions which improve employee performance. Proper laptop/computer usage leads to increased productivity [6]. In contrast, awkward wrist placements while typing on a keyboard or using a touchpad, a lack of arm support, puts tension on the upper back, and greater strain on the neck, which is bent to gaze down at the screen; these all contribute to increased strain on the upper back [64]. In contrast, a correctly positioned external monitor, with respect to eye level, would eliminate the uncomfortable arm, neck, and back postures that are likely to contribute to higher pain levels [65]. Furthermore, the advantages of an external mouse and keyboard would allow an individual to maintain healthy, more neutral hand postures and allow a laptop monitor to be adjusted to an acceptable height when an external monitor is not accessible. Another issue in our survey results was the lack of an ergonomic chair with adjustable armrests, a strong back with lumber support, and adjustable seat height, which was another important factor causing poor health. Since people used a work surface in their homes, they expected to face various discomforts related to it. Faculty members who used a laptop in these settings were statistically more likely to face stress due to their inappropriate sitting choice, such as working on a dining table, a sofa, or a bed.

The findings of this study show that there is potential space for ergonomic improvement in the home office. Ergonomics training has been shown to be useful in lowering discomfort in both home-based offices and also in a workstation [66]. The necessity of boosting office ergonomic knowledge can play a vital role in empowering home office workers to mitigate the strong negative impact of current pandemic. In our data analysis, fifty per cent of respondents used poor work surfaces at their homes, so increased ergonomic awareness is required to empower home office workers to make positive changes in their work environment while at home [67]. As pandemic continue to impact the spheres of work and life and it causes disturbances for workers around the globe, there is a compelling case that better workspaces will not only benefit workers' well-being but may also be financially beneficial to organisations. Providing improved support for their employees' physical and mental health could reduce downtime and compensation claims resulting from injuries caused by prolonged strain in non-ergonomic settings.

Literature suggests that since the pandemic outbreak, a plethora of studies have investigated the disruptions in the contexts of university students but studies examining pandemic impact on work design-related issues of university teachers are either too rare or of a very initial or preliminary nature, lacking detailed analysis. It seems that despite critical nature of the issue, it has unfortunately not attracted significant attention from the research community. Therefore, we argue that present study is a substantial step; it is of appealing nature and has potential to draw attention of various stakeholders, including, researchers, university/HEI authorities, governments

and other institutions to address issues related to workplace ergonomics. Because, timely solution of such issues will create positive impact on the teachers' (faculty's) health which can resultantly have positive effect on students, the education system and overall learning landscape. "

In view of the ongoing pandemic and its continual nature, present study recommends that universities/HEIs may benefit from this study if they follow these few suggestions: 1) Issuance of checklist/tips for setting up ergonomically appropriate offices at home. 2), Per-employee allocation of a separate budget for minimum required material, inventory, equipment, furniture, etc. for setting up ergonomic home office. 3) Arranging awareness seminars for employees to understand possible health-related issues while working from home. 4) In consultation with organizational psychologists and occupational therapists, universities/HEIs can better manage and make arrangements for employee health issues while working from home. 5) Devising relatively realistic policies different from pre-pandemic period, with due consideration of mixed employee roles (i.e., parallel involvement in work and home affairs from an off-site location).

From future research directions perspective, we recommend Participatory Ergonomics Model (Punnett et al., 2013) as a means to achieve ergonomic interventions to mitigate Covid-related ergonomic issues in future. Present research adopted three dimensions to measure ergonomics in the context of Covid, future research may also investigate ergonomics from other aspects which this research did not cover. Moreover, as our study focused faculty of universities/HEIs, applying investigative approach of present study in other sectors/industries may bring different results which may help to identify other related factors.

6. Conclusion

Present study shows the apparent degree of discomfort suffered by academic staff due to the continuing pandemic as there has been significant increase in the levels of discomfort following the stay at home orders. There are numerous sources of potential discomfort caused to workers; these are wide use of laptops, work on suboptimal workstations, such as sofas, beds and kitchen counters, that have been reported. Home-based working conditions resulted in many harmful work conditions, such as laptops with too low monitors, chairs without armrests, hard surfaces on desktops and long static poses due to lack of routine breaks. Since we have converted to home offices, employees do not have the resources to adequately set up workplaces at home. Educational institutes need to ensure that workers have adequate equipment such as an adjustable office chair, adjustable monitor, an external mouse and keyboard. In addition, organisations should provide their employees with adequate ergonomic training to prevent the development of potential musculoskeletal disorders. Given that published research concerning 'pandemic and workplace ergonomics' is of preliminary [49] or exploratory [33] nature, present study is a step forward to pave the path for further explanatory research in the field of workplace ergonomics in Pakistan. This study is among very few studies that highlight importance and sensitivity of the workplace ergonomic issues faced by faculty members of higher education sector. We insist that present study has unique significance for proposed workplaces and can play an instrumental role in transforming pandemic-hit office spaces/design of Pakistani universities and HEIs.

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