https://doi.org/10.48047/AFJBS.6.7.2024.2471-2486

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

REVIEW ARTICLE

The biomechanical analysis of the hand for the purpose of surgical ergonomics – A systemic review

[1]Singh S, [2]Sharma N, [3]Jain S.K, [4]Sharma S

[1]PhD scholar, [2]Professor, [3]HOD & Professor, [4]Assistant Professor, India

Corresponding Author:
Shikha Singh
Email: soniyasharma.mbd@gmail.com, ORCID id- 0009-0006-8821-2068

Article History
Volume:6,Issue7,2024
Received: 21April2024
Accepted:27May2024
doi:10.48047/AFJBS.6.7.2024.2471-

ABSTRACT

Introduction: The hand of the human is a complicated yet sophisticated structure that is Essential for performing various functions on a daily basis. This article provided a review of the literature on the methodologies used to assess the biomechanical efficiency of the hand, including anthropometry, kinematics, kinetics, and electromyography. The dimensions of the hand are described by anthropometry.Kinematics is the study of all hand movements and the range and type of motion of finger joints. Tendon and joint-free analysis are covered by Kinetics. Signal-processing Technology is used in EMG to better understand the muscles of the hand and their associating functions.

Materials and Methods: For this study, articles published between 1990 and 2022 were thoroughly searched utilizing the PubMed, Elsevier Science, and Google Scholar databases. The research was limited to English-language publications that had the phrases "hand function," "hand anthropometry," "hand kinematic," "hand kinetic," "EMG of the hand," "finger joint angle," "finger tendon force," or "biomechanical hand model" in the title, abstract, or keywords. Factors like Author, Journal, Year, Scope,data, study design, identification precision, and Conclusion were taken into consideration during the analysis.

Results: A total of 1765 publications were found, but 60 studies were adopted for the meta-analysis afterbeing judged to meet all selection criteria. Five methods for analyzing hand function based on a biomechanical approach were implemented in this research. These methods included anthropometry, kinematics, kinetics, and electromyography, handgrip strength.

Conclusion: This study provides a review of the literature on various technologies and methodologies used for hand-function analysis, based on a biomechanical approach and the results of earlier studies relevant to hand functions. The four hand-function analysis categories listed below are covered: In that sequence, kinematics, kinetics, electromyography, and anthropometry are list.

Keywords: Ergonomics 1; hand grip strength 2; biomechanical hand model 3; electromyography 4;

INTRODUCTION

The International Ergonomics Association defines ergonomics as "the scientific discipline that is concerned with the understanding of variousinteractions amongst humans and the other elements ofa working system, and the profession that applies theory, principles, data, and methods to design a system in order to optimize human well-being and performance"[1]. A significant area of ergonomics is physical ergonomics. Studying the size and form of things in relation to the anthropometry of the many people who must interact with them in order to make changes is one of the key objectives of physical ergonomic. Ergonomics hand models are used to simulate the postures used when grasping objects with distinct functions and grips. As a result, the main needa model for ergonomic is that it must support the depiction of various populations and percentiles. When grabbing the same thing for the same purposes, people with different-sized and- proportioned hands will assume various stances.[2]

The hand is a daily essential. It is used in all daily activities both personal and in the professional field. Musculoskeletal conditions (MSDS) like De Quervain's tenosynovitis, trigger finger, ganglionictumors, hand-arm vibration syndrome, andblackberry thumb are more common in the hand than in the lower extremities.[3] When a work requires greater hand strength than the worker is able to use, repeated motion, and awkward postures can result in hand discomfort and injury.

As a result of their diminished grip strength and ability, people with hand MSDS are restricted in their activities.[4] An essential and fundamental requirement for many movements, such as object handling, is a secure handgrip. In particular, biomechanical methodologies have traditionally been used to assess the physical capability of the hand. The four subfields of biomechanical research on the human hand are anthropometry, kinematics, kinetics, and electromyography.[5] The Eulerian angle model and Cheng and Pearcy's model are widely applied to assess the angle, velocity, trajectory, and acceleration of a motion according to the observed markers.[6,7,8] Anthropometry, kinematics, kinetics, and Electromyography are thefour subfields of the biomechanical study of the human hand.[9] To examine the angle, velocity, trajectory, and acceleration of a motion according to the measured markers, the Eulerian angle modeland Cheng and Pearcy's model are frequently employed.[10,11]

The most popular motion analysis model for describing how a rigid body is oriented in space is the Eulerian angle model. By using three rotations and Eulerian angles, every direction in Space is obtained. This makes it possible to determine the supination/pronation, abduction/adduction, and flexion/extension of the finger joint. Each model thus employs a unique set of mathematical techniques. This model is used to
compute the acceleration, velocity, and trajectory. Incontrast to Cheng and Pearcy's approach, the Eulerian angle model is capable of calculating the
rotation angle.

The Eulerian angle model is the most well-liked motion analysis model that describes how a rigid body is orientated in space. By using three rotations and Eulerian angles, every direction in Space is obtained. This allows for the calculation of the fingerjoint's flexion/extension, abduction/adduction, and supination/pronation. Each model thus employs a unique set of mathematical techniques. This model is used to compute the acceleration, velocity, and trajectory. In contrast to Cheng and Pearcy's approach, the Eulerian angle model is capable of calculating the rotation angle. On the basis of 3D joint rotations, the Eulerian angle model, however, may overstate or incorrectly interpret the flexion/extension and abduction/adduction angles.[12] To understand and choose straightforward and acceptable procedures, non-experts in the field of biomechanics-such as hand-tool designers and safetysupervisors-need an in-depth understanding of the technologies and methodologies used for hand analysis.

ERGONOMICS

The Greek word Ergon meaning labor, and Nomia, meaning arrangement, comprising "ergonomics," is described by the International Ergonomics Association Council.[13] The official description is that Ergonomics is "the science that deals with the design of things that people use in their work and everyday life and the environments in which they work and live, taking into consideration the human characteristics." To improvise security, health, welfare, and well-being, ergonomics utilizesresources from the human- related sciences to meet an individual's

physical, social and mentalcredentials concerning duties and atmospheres. The aim of doing this is to yield outstanding workplace productivity.[14]
In common language, it is the research that encloses the nurturing of the most useful relationship of function, equipment, and user.
Healthcare is well known as one of the world's one of enormous fields financially and in manpower, it provides employment to millions of individuals. It is the fastest growing industry due to rise of the ageing seniorcitizens and discovery of novel and rare healthcare challenges. The rate of increasing occupational injuriesand ailments in the healthcare and wellness in the healthcare universe is greater than the usual private industry and is at an exponential rise. Even with the advent of newer technology and approaches, ergonomic issues in the healthcare industry continues to increase. Contemplating the characteristics in ergonomics-related problems is critical to developing efficient interventions. Being assertive, being quick, focused, immaculate coordination, and perfect execution of movement, surgeries require perfection.
An energetic and dynamic atmosphere is present in the Operation Theatre. A procedure is in continued progresswhen abruptly, the condition changes. Mostly, the surgeon will adapt a poor, ergonomically not favorable position so as to expose, access, and increase view of thesurgical area of interest.
Do no Harm is the main focus of the medical professionals up until lately; the soundness of the physician has been overlooked. While the patient's
wellbeing is always considered first, the healthcare and research sectors are gradually becoming astounded of and enabling support to the requirements and welfare of medical professionals. In order to minimize injuries and to ensure the wellbeing of employees, to improvise the machine interface, and to accelerate efficiency, newer technologies and products are introduced, maintaining the ergonomic standards. Due to the nature of their dailytasks, which include standing in uncomfortable positions, handling supplies and instruments, and working long hours, healthcare workers face significant ergonomic challenges and issues. The equipment's, tools, and gadgets, used in the operation theatre might not be up to the mark of the user, leading to Musculo- skeletal troubles; the scrubs might lead to allergies which might lead to anaphylactic shocks; the working hours, strain and stress of work might lead to early lifestyle ailments.
Improvising ergonomics at work place may decrease stress, strain, and fatigue amongst workers as well as aiding the surgical team of doctors to prevent musculoskeletal injuries and improvising performances. Occupational therapists work in an atmosphere where there are ergonomic dangerous factors that may result in musculoskeletal disorders (MSDs).[15]
Work-related musculoskeletal diseases (W.M.S. Ds) are injuries that affect the muscles, tendons, nerves, joints, and other parts of the musculoskeletal system.[16] The most often affected muscle groups amongst surgeons are those present in the neck, shoulders, and lower back, with an occurrence of 20%-70%[17] WMSDs in surgeons may result in various diseases, these include carpaltunnel syndrome, lumbar and cervical radiculopathy, varicose veins, and rotator cuff illnesses[18] These damages have a huge impact not only on the surgeons' capability to operate, but also on proper patient care. One of the common reasons for healthcare workers to slip work is WMSD that has been demonstrated to affect proprioception, grasp force, mobility, and handling ability. As a result, the number of healthcare workers is indirectly reduced, this increases patient's waiting times,decreases patient satiety, and decreases standards of care[19] feels that the increasing complexity of the dental surgical environment may have an impact on the efficiency and flow of work for dental professionals. Recent technological innovations have resulted in the invention of several advanced gadgets. Without any of them having a designated use for surgery this might lead to a surgery with an extended and dispersed operational set up, which could enhance the risk of uncomfortable circumstances and inappropriate stances while the physician is working.

The avoidance of WMSDs and increased productivity and efficiency are key components of a general improvement in the working environment for practitioners that resulted from ergonomic design suggestions for dental surgery. For the practitioner's convenience, it was advised that headrests and backrestson patient chairs should be small and easily adjusted. For the safety of the operator, patient placement shouldlean more toward supine than semi-reclined. This will lessen the need to rotate around the midsection in orderto view into the mouth. The operator's recliner must accommodate the back muscles & abdominal muscles inorder to reduce tiredness. Generally, chairs have a good lumbar support and height-adjustable arm supports to make sure that the body is erect, normal posture and the feet are kept flat on the ground. The lower back supports an enduring issue. One of the more recent prototypes include to provide enough abdomen assistance and lessen lower back muscular tension, an anterior aid which is customized to the patient's chair is used. Achieving a proper posture and reducing eye strain require working in proper conditions with the correct lights and magnification. When the best direct view is going to be used, then illumination must not interfere with perception or must be radiating off the crystal surface. In order to facilitate access in the event that the angle or location of the light needs to be adjusted, the observing angle should never deviate more than 15 ° outfrom line of vision. Following such advice in terms of the procedure in the dental office and devices choices may boost clinician and practice comfort, efficiency, and production while improving patient comfort and ensuring that his or her requirements are met. Only a few orthodontists had previously been researched, thereforethe majority of the information came from earlier studiesof MSDs in dentists. Since general dentists and orthodontists do different kinds of work, their working postures must also differ from one another. To what extent the changes between both the groups are sufficient to have a clinically relevant effect is currently not known due to lack of sufficient data.[20]
Anthropometry is the word used to describe the most comprehensive and precise method of illustrating the body's physical measures.[21,22]

MATERIALS AND METHODS

Search Strategy: For this study, articles published between 1990 and 2022 were thoroughly searched utilizing the Google Scholar, Elsevier Science, PubMed, and Science Direct databases. The search was limited to English-language publications thathad the phrases "hand biomechanics," "hand function," "hand anthropometry," "hand kinematic," "hand kinetic," "EMG of the hand,""finger joint angle," "finger tendon force," or "biomechanical hand model" in the title, abstract, or keywords. Factors like Author, Journal, Year, Scope, data, study design, identification precision, and Conclusion were taken into consideration during the analysis.The systematic review was conducted in accordance with the PRISMA recommendations. Publications were thenanthologized, according to selection and elimination procedures, and finally screened forthe full-text article for additional clarity of the selection procedure. In this systematic review, we analyzed the articles according to the classification of various methods for the measurements of hand dimensions:

1. Anthropometry
2. Functional method (EMG, Hand gripstrength)
3. Kinematic method (Range of motion)

Inclusion Criteria

All the articles that were using various methodologies for hand-function.
Studies analyzing the hand grip strength.

Exclusion Criteria

Literature not available in English language

Table 1: Anthropometric method and biomechanical hand model in previous studies

References	**Publication Year**	**Study population**	**Study design**	**(participants)**	**Measurers**	**Outcome**
LailaRazzaque[23]	2021	Bangladesh	Cross-sectional	300 females	Finger spans, Hand grip strength	Designing hand instruments can benefit from using anthropometric measurements of the hand.
Ovidio Rincón-Becerra[24]	2020	Colombian population	Observational	41participants	22 hands Anthropometric parameters	Estimated measurements were obtained
Amare Wibneh[25]	2020	Ethiopian male		250 males	Anthropometric database of Ethiopian army	Age, ethnicity, and cross-national comparisons of anthropometry were made.
Perugu Vanishri[26]	2019	South Indian	Cross Sectional Study	192subjects	Hand length,hand breadth	From hand length and breadth, anthropometric measurements may be utilizedto determine stature.
ArgiSoni[27]	2018	Different Nationalities Malaysia,Chinese,India	Observational students	259 university	Hand length and stature	Established anthropometric parameters for determining the height of Malaysia's three main races.
Nuriye Kübra Bayraktar[28]	2018	Turkey	Cross-sectional	141students	Hand length and width	Males are longer and wider than females.

RavneetSandhu[29]	2017	Amritsar, Punjab, India	Cross-sectional study	100 young healthy men and females	Height, weight, body mass index (BMI), hand length, hand width, and hand grip strength	Males have stronger grips than females.
ArchanaChahal[30]	2014	Allahabad ,India	Observational	37district junior male basketball players	Height, weight, hand width, hand length and hand span,	Except for the hand length, which was not significantly different, the left hand's hand breadth and hand spread were both larger.
Umama NisarShah[31]	2012	Karnataka	Cross-sectional study	50 healthy female subjects	Anthropometric measures of the hands and forearms, as well as height, weight, and body mass index (BMI).Grip strength in both the dominant and non-dominant hands	The findings demonstrate positive correlation between hand grip strength and height, weight, hand length, hand spread, wrist Circumference, and fore arm girth. In healthy Indian females, hand grip strength does not correlate with BMI or hand width.
AruneshChandra[32]	2011	Haryana	Observation	878	Internal grip diameter, grip span, hand length and hand circumference.	All values between the hand length and hand circumference are substantial and positively associated.

Table 2: Functional (EMG) method and biomechanical hand model in previous studies

References	Year	Study population	Study design	(Participants)	Measurers	Outcome
Néstor J.Jarque-Bou[33]	2021	Spain	Cross sectional	42 subjects	EMG of hand and forearm muscles	To enhance rehabilitation procedures, control of prosthetic devices, a better knowledge of human hand behavior, and more accurate biomechanical models, the most significant problems and unresolved Concerns are listed.
M.A. Aceves-Fernandez[34]	2019	Mexico	Observation	50 subjects	EMG Signals, EMG Classification	The findings were contrasted with those from conventional machine learning techniques, and the benefits of using the suggested methodology over them are emphasized.

Table 3: Functional (Hand grip strength) and biomechanical hand model in previous studies

References'	Year	Study population	Study design	(participants)	Measurers	Outcome
Razzaque L.[35]	2021	Bangladesh	Observational and cross sectional	300 females	Five finger spans and hand grip strength were tested.	Age-related differences in grip strength were clearly seen in both hands. Age-related variations in finger spans were non-significant. The identical hand's finger lengths and grip tensile strength were positively correlated.
Shaheen M.[36]	2021	Saudi Arabia	Cross-sectional study	139 healthy females college students	Hand Grip Strength and Pinch strength	When evaluating hand function throughout the rehabilitation process, normative values can be utilized as a therapeutic guide while taking the population's age and palmar breadth into Consideration.
Sandhu R.[37]	2017	Punjab	Cross-sectional study	100 male and female	Using a Jamar dynamometer, hand grip strength was evaluated.	Males tend to have stronger grips than females.
Rawat S.[38]	2016	India	Cross-sectional study	375 healthy Indian females	Weight, forearm length, arm length, hand	Grip strength may be predicted in Indian office-going females using anthropometric measures

					width, hand gripstrength, and body mass index(BMI)	and body Composition factors. Hand grip strength is closelyrelated to These variables.

Table 4: Kinematic method and biomechanical hand model in previous studies

References'	Year	Study population	Study design	(participants)	Measurers	Outcome
Néstor J.Jarque-Bou[39]	2020	Spain	Cohort study	22 health ysubjects	Digit arching (flexion of the proximal interphalangeal joints), palmar-thumbcoordination (coordination of the palmar and carpometacarpal flexions of the thumb),thumb opposition, and thumb arch are all instances of flexion and abduction of the meta carpophalangeal finger joints.	It may be advantageousto choose activities for rehabilitation and handfunction evaluations if groups of tasks with comparable kinematic needsin terms of synergy arefound.
Jumana Ma'touq[40]	2018	Germany	Cross Sectional Study	100 participants	MCP flexion/extension, and abduction/adduction, proximal interphalangeal, and distal interphalangeal	A fundamental linear correlation between surfaceand skeleton Rotational angles was discovered after we were able to enhance literature.
Henk G Kortier[41]	2014	Netherlands	Cross Sectional Study	100 subjects	Inertial sensors used in an ambulatory system that is maybe linked to the hand, fingers, and thumb. It allows for the precise positioning of the hand as well asthe full 3D reconstruction of all finger and thumb joints. Experimental evaluations were	Inertial and magnetic sensorsare significant for ambulatory examination of the human hand and finger kinematics, according to this study's findings regarding static accuracy, dynamic range, and repeatability. It makes it possible to estimate joint movements with

					done to determine the static accuracy, dynamic range, and repeatability of the system.	a number of degrees of freedom using inexpensive sensors.

Table 4: Kinetic method and biomechanical hand model in previous studies

References'	Year	Study population	Study design	(participants)	Measurers	Outcome
Onathan L.Morse[42]	2006	South Korea	Cross Sectional Study	20 participants	Height, Gender Angle, Direction Velocity, Direction Angle, right hand and arm injuries.	These findings can aid in the assessment of cumulative trauma syndromes, but further study on the dynamic measurements of the hand and wrist complex and the creation of dynamic force measuring standards are required.

ABBREVIATIONS

(EMG) -Electromyography(ROM)- Range of motion
(MSD)- Musculoskeletal disorder (sEMG)- surface electromyography (RMS)-Root mean square
(MPF)-Mean power frequency
(MVC)-Maximal voluntary contraction

DISCUSSION

The science of anthropometry includes methods for analyzing the data from manual measurements. Technology is used in kinematics to assess the ROM of each hand joint, including those in the fingers and wrist. Kinetics is the study of technology and a variety of kinetic hand models for analyzing joint and tendonforces. EMG provides information on the muscles of the hand and the functions associated with it, Signal processing technology, and SEMG technology.

According to the study's objectives, anatomical measuring variables are often categorized for use in general or application surveys. A general survey's primary goal is to describe a population, and it does this by measuring a wide range of people's hands. In contrast, an application survey simply selects and measures the factors that are closely relevant to the product under consideration. It also examines fewer and more precise dimensions. As a result, depending on the goal, different dimensions and populations are measured. However, insufficient research was done to determine the ideal person count and related parameters.[43] Therefore, to establish the ideal sample size for obtaining accurate statistical information, a thorough assessment of hand Anthropometry is necessary. Kinetics research has examined the force, moment, and torque in tendons and fingers. Both direct and indirect measurements of these variables arepossible. The instruments employed include force gloves, pinch gauges, dynamometers, new force transducers, and tendon force measuring devices. Hand functions are coordinated by intrinsic and extrinsic muscle groups. In a hand-function study utilizing SEMG,[44] six extrinsic muscles are typically examined. Hence, using electromyography during contractions that change throughout time necessitates many interpretations than doing so during static ones. So, it is obvious that the biomechanical approach of the hand is a multidisciplinary study of the mechanical force and movement of the musculoskeletal system of the hand. With the use of biomechanical research, hand instruments may be designed more expertly and effectively.

The estimation of human physical characteristics is called anthropometry. The mean of the human population has changed in terms of physical size with the evolving time. People these days are often heavier and taller than in prior generations. According to the science relating anthropometrics, population dimensions are evaluated based on population size, strength, and other characteristic features.

These measures are used to garner a collection of information with regards to in terms of shape and size, corresponding to the proportion of population under study[45] Individual physical qualities interact with extrinsic elements in the environment when carrying out any specific job activity in order to affect the development of musculoskeletal complications. The next section will assess quickly what is known about how women and men differ with regards to anthropometry as this specific work focuses on how sex variations in anthropometry intermingle with extrinsic job variables to impact the gradual development of work- related musculoskeletal complications and illnesses.

Designing hand-guarded, hand-controlled,and hand-operated instruments is possible with the use of hand anthropometry data. It is convenient to measure hands using a variety of instruments and gadgets. These days, 3D scans are the method of choice since they can simply and precisely assess a variety of hand regions. In a static condition, the measurements of the hand are mostly measured under the crease of length, width, and circumference.[46]

A large number of researches have been done to assess the, trajectory, acceleration, angle, & velocity of various hand related functions. Various instruments are often used to gauge different functions of hand like goniometers, electro-goniometry, x-rays, MRI, & motion analysis by markers based. Commontechniques for clinical observation include X-ray and MRI examinations. However, radiationexposure is a possibility with X-ray measurements.[47] It is challenging to use goniometry to assess the thumb trapeziometacarpal joint.[48] In a bid to compensate for such limitations, recent research is aggressively examining the application of motion detection methods for evaluating hand capabilities. Although they continuously analyze both movement & posture by calculating three - dimensional motion analysis.

A 3D motion analysis system is often used ina variety of disciplines for the accurate evaluation of kinematic parameters. In comparison to previous techniques, this technique is more reliable in obtaining 3D data.[49] Three-dimensional motion evaluation is required to analyzed the kinematic parameters for the kinematic hand model and marker attachment approaches. Even though any marker attachment method is appropriate here, the "one marker per joint" method is advised for increased patient comfort and simple marker insertion in static settings. Due to their robustness to skin movement, the "three markers per segment" and "cluster marker" approaches are advised for studies carried out in dynamic environments since they evaluate hand motions more precisely.[50]the hand's most significant and developed component, with the widest Range of functions[51] Therefore, future studies will look at the thumb's ROM and functionalities,which will be assessed in three dimensional.

In general, direct and indirect measurements may be used to categorize the technologies for kinetics evaluation. The outside load is normally evaluated, whereas the interior weight is frequently predicted analytically utilizing kinetic models.[51] Measure the force, moment, of functions of the hand, has been the focus of several earlier investigations. Appropriate anthropometry information, like segment mass, and center of gravity, is needed to evaluate these in a joint. For the formation of hand kinetics models in future studies, precise anthropometry data of the hand is also required.[53]

With the increasing prevalence of laparoscopic procedures, practitioners are reporting fatigue and discomfort of varied varieties. The most common discomforts reported are located in the arms, neck, and upper back.

In order to study the mechanisms of the muscular fatigue, EMG is one of the best methods. This is because EMG measures and evaluates the Action Potential and Resting Membrane potential of muscles. The quantification of physical workload and muscular discomfort by EMG is a known method and frequently used by ergonomists. An efficient way to assess a variety of biomechanical traits, such as muscular action, exhaustion, and propagation pace, is through Surface EMG (sEMG) analysis.[54] The firing rate in sarcolemma is the action potential in a musculoskeletal system and is dependent on strength of stimulus. An assessment of usage of muscle and the muscular loading magnitude along with its relation to muscular effort is provided by EMG.[55] Evaluation of muscle activation throughout various professional tasks is common.[56] Christensen defined muscular exhaustion as a decrease in a muscle's abilityto generate force. Both intrinsic and extrinsic groups of muscles of hand region are accountable for various aspects of hand physical functioning. Contrary to intrinsicmuscles, that is entirely found in the hand and is responsible for the digit motions, and the extrinsic compartment of the muscles are noticeably significantly larger.

The extrinsic muscles are further divided into the anterior and posterior groups where each can further be classified as superficial or deep muscle. The anterior muscles perform the function of flexion and extension is the action of the posterior muscles. The most crucial EMG procedures are selecting the appropriate muscles, correctly attaching the electrodes, and selecting an appropriate signal-processing technique for the intended research. The hand muscles thatare most frequently utilized to test the hand's efficiency using EMG, the majority of investigations have employed signal-processing techniques like RMS and MPF. Dynamic hand functions have not been considered in prior research on muscle exhaustion and features accordingto the Electromyography signals. They just took into account the MVC's relative muscular activity. Dynamic hand movements, on the other hand, include the depth and length of the muscle fibers, which fluctuate over time and space. As a result, alterations take place between the muscle fiber and the SEMG electrode. Moreover, as the muscular contraction velocity changes, a muscle- tendon moment differential is produced.[57]Because of this, the electromyography signal for dynamic hand activities must be interpreted in different ways than for static hand functions.

Hand grip strength has been noted as an important factor in predicting impairment in musculoskeletal complications, risk of falling, cracks in osteoporosis, and thickness of bone minerals. Three studies that looked at how hand dominance affects grip strength found that the dominant hand had statistically significant grip strength advantages over the non-dominant hand.[58]

A sturdy wrist is necessary for power gripping. According to biomechanics, a stable wrist prevents the forces generated bythe tendons as they travel across the carpus from dissipating. One of the most intricate biomechanical systems is the human hand. A succession of longitudinal and transverse arches is formed by a system of bony segments.[59] In essence, there are two transverse arches: the distal transverse arch,which is produced by the metacarpal heads of the fingers, and the proximal transverse arch, which is formed by the carpal bones. The five digital rays' bones make up the longitudinal arches. The carpal bones are thepoint at which the proximal transverse and longitudinal arches converge. Therefore, the longitudinal arches and other key structuresfor hand function both benefit from the stabilizing effects of the carpal bones. Because the arch biomechanically resists more force than other structures, arches are commonly used in both ancient and contemporary engineering and architecture.Carpal bones are a component of the joint motion arc and aid in stabilizing hand motion. The lengths of the metacarpal, proximal phalanx, middle phalanx, and distal phalanx bones all fall within the Fibonacci ratio of 1:1.618034, which is wellknown. According to observations made byother researchers[60] the ratio is better suited by these bones' functional lengths calculatedusing the joints' centers of rotation than by their absolute lengths. In addition to the Parthenon in Greece, this ratio can also be found in the nautilus shell, sunflowers, eggshells, spiral galaxies in space, and sunflowers. The surgeon's job is to minimize this functional loss by restoring the anatomy where it is feasible and tricking Mother Nature when necessary. This geometric design, in this ratio, and the bonystructures of the hand produce an equiangular spiral of joint motion arcs. The hand may be described as consisting of a stable wrist and a minimum of two digits that can exert some force on one another. Forgrasping to be possible, it is ideal for one or both of the digits to be mobile. One digit canbe stable and have mobility in its simplest form so that it can move against the stable post. Digits gain from feeling things and from not hurting, which makes it easier for them to be used. The majority of hand functions are made up of seven biomechanical hand movements.

CONCLUSION

Simply said, Hand anthropometry serves as the foundation for biomechanical analysis. The most typical measuring variable is the range of motion (ROM). Designing hand devices and hand rehabilitation often involves using ROM and anatomical measurements. The (3D) motion evaluation model is now the most used technique for evaluating kinematic variables such as trajectory, angle, velocity, and acceleration.For analysis and comparison, this system requires pre-set markers and kinematic models. Based on the requirements of various researches, a variety of sets and models have been created, and the system's accuracy has increased significantly over time. As a result, the data gathered by this system helps to broaden researchers'understanding, enabling them to select an appropriate method for development and improvement. The most frequent applications of EMG in research are to measure muscular activity, exhaustion, and conduction velocity. Effective assessment requires an understanding of signal processing methods, electrode placement, muscle location, and the operation of the EMG instrument. In clinical settings, handgrip strength is a key factor in physicalstability and overall health. In older people, it also helps predict general morbidity, complications following surgery, and surgical outcomes. The prevention of MSDS is crucial for enhancing working conditions and performance, which calls for the application of certain biomechanical concepts. In reality, the hand is primarily assessed to minimize the risk of musculoskeletal disorders. This study provides a review of the Literature on a few technologies and approaches for analyzing hand functions that are using a biomechanical methodology and thefindings of prior research on hand functions. Analyses of the four hand-function categories-anthropometry, kinematics, kinetics, and electromyography are included.

With the advancement in medical science, different technologies are being incorporatedto improve the efficiency of medical professionals. Various new instruments havebeen developed to save the human life. But the only dilemma is that they are designed according to the anthropometric parameters of kinematic hand model developed by European countries.

It is an established fact, that Indian parameters differ widely from other countriesdue to its genetic and geographical pattern.

Besides this, lot of literature is available regarding the anthropometric parameters of Indian hand in both the sexes. But, for the development of kinematic hand model, otherparameters like finger joint angles, finger tendon force, range of movements, muscle strength etc. are also required. So, our study will provide these parameters to develop Indian hand kinematic model.

ACKNOWLEDGEMENT

I would like to acknowledge teaching and technical,nontechnical staff.

REFERENCES

1. Sekigami Y, Tian T, Char S, et al. (2022). Conflicts of intrest in studies related to mesh use in ventral Hernia Repair and abdomen wall reconstruction. Ann Surg. 1;276(5): 571-76, 2022.
2. Annesha P (2022).Ergonomic Issues Faced by Surgeons in opration theatre 3;2022, Manuscript No. JER-22-16488; Editor assigned.
3. Armstrong TJ, Foulke JA, Joseph BS, Goldstein SA. Investigation of cumulative trauma disorders in a poultry processing plant. Am Ind Hyg Assoc J;43(2):103-16, 1982.
4. Degeorges R, Parasie J, Mitton D, (2005). Three- dimensional rotations of human three-joint fingers: an optoelectronic measurement. Preliminary results. Surg Radiol Anat. 2005 ;27(1):43-50. doi: 10.1007/s00276-004-0277-4.
5. Lee KS, Jung MC (2013). Biomechanics and physical ergonomics. In: Haight JM, editor. Handbook of loss prevention engineering. Wiley VCH; 2013. p. 357-371. https://doi.org/10.1002/9783527650644.ch15.
6. An KN, Ueba Y, Chao EY, (1983). Tendon excursion and moment arm of index finger muscles. J Biomech. 1983;16(6):419-425. doi: 10.1016/0021-9290(83)90074-x.
7. Chiu HY, Su FC, Wang ST, (1998). The motion analysis system and goniometry of the finger joints. J Hand Surg Br. 1998 Dec;23(6):788-791. doi: 10.1016/s0266-7681(98)80098-3.
8. Chao EY, Opgrande JD, Axmear FE (1976). Three- dimensional force analysis of finger joints in selected isometric hand functions. J Biomech 1976;9:387-396 https://doi.org/10.1016/0021- 9290(76)90116-0.
9. Lee KS, Jung MC(2013). Biomechanics and physical ergonomics. In: Haight JM, editor. Handbook of loss prevention engineering. Wiley- VCH; 2013. p. 357e71.
10. Chao EY, An KN, Cooney WP, Linscheid RL. Biomechanics of the hand. World Scientific; 1989.
11. Laila Razzaque1 Md. Ashrafuzzaman2 Monjurul Hakim3 Chattogram Maa-O-Shishu Hospital Medical College Journal 20, 1, 2021.
12. Chao EY, Opgrande JD, Axmear FE (1976). Three- dimensional force analysis of finger joints in selected isometric hand functions. J Biomech 1976; 9:387e96.
13. Sekigami Y, Tian T, Char S, et al (2022). Conflicts of Interest in Studies Related to Mesh Use in Ventral Hernia Repair and Abdominal Wall Reconstruction. Ann Surg. 2022 1; 276(5):e571- e76. 2021 11. PMID: 33443908.
14. Annesha Pradhan Ergonomic Issues Faced by Surgeons in Operation Theatre 3-Mar-2022, Manuscript No. JER-22- (R); 07-2022, 7556.22.12.301.
15. Ia N, Zhang H, Ling R, Liu Y, Li G, Ren Z, Yin Y, Shao H, Epidemiological Data of Work-Related Musculoskeletal Disorders - China, 2018-2020. China CDC Wkly. 2021 30;3(18):383-89. PMID: 34594889.
16. Epstein S, Sparer EH, Tran BN, Ruan QZ, Dennerlein JT, Singhal D, Lee BT. Prevalence of Work-Related Musculoskeletal Disorders Among Surgeons and Interventionalists: A Systematic Review and Meta-analysis. JAMA Surg. 2018 21;153(2): e174947. 2018 21. PMID: 29282463.
17. Forst L, Friedman L, Shapiro D. Carpal tunnel syndrome in spine surgeons: a pilot study. Arch Environ Occup Health. 2006; 61(6):259-62. PMID:17967747.
18. Wright ME. Long-term sickness absence in an NHS teaching hospital. Occup Med (Lond). 1997; 47(7):401-6. doi: 10.1093/occmed/47.7.401. PMID: 9374068.
19. Sakzewski L, Naser-ud-Din S. Work-related musculoskeletal disorders in Australian dentists and orthodontists: Risk assessment and prevention. Work. 2015; 52(3):559-79. PMID: 26409367.
20. Stylopoulos N, Rattner D. Robotics and ergonomics. The Surgical clinics of North

America. 2003; 83 (6):1321–37. 2004/01/10. PMID: 14712869.
21. Afaq S, Jain SK, Sharma N, Sharma S. Acquisition of precision and reliability of modalities for facial reconstruction and aesthetic surgery: A systematic review. J Pharm Bioall Sci 2023;15: S849-55.
22. Rai A, Sharma N, Jain SK, Lalwani A, Sharma S. Accuracy and reliability of different approaches for the assessment of pelvic floor muscle strength: A systematic review. J Pharm Bioall Sci 2023;15: S856-61.
23. Bennis N, Roby-Brami A. Coupling between reaching movement direction and hand orientation for grasping. Brain Res 2002; 18:257e67.
24. Bazanski T. Metacarpophalangeal joint kinematic during a grip of everyday objects using the three- dimensional motion analysis system. Acta Bioeng Biomech 2010; 12:79e85.
25. Wibneh A, singh k A, Karmakar S, Anthropometric Measurement and Comparative Analysis of Ethiopian Army Personnel Across Age, Ethnicity, and Nationality Defence Science Journal,2020,4;70: 383-396, DOI: 10.14429/dsj.70.15435.
26. Vanishri, Perugu, Sheikh, Nishat, Anthropometric Measurements of Hand Length and Breadth for Estimation of Stature in South Indians 2019,01;01:124-130 V: (12) DO- 10.21088/ijfmp.0974.3383. Indian Journal of Forensic Medicine and Pathology.
27. Gargi S, Anuar, Fatin A, study of Anthropometric Measurement of Hand Length and their correlation with Stature in university Students 2018, 8(1):32- 38.
28. Néstor J. Jarque-Bou, Margarita Vergara Hand Kinematics Characterization While Performing Activities of Daily Living Through Kinematics Reduction received October 17, 2019; 22, 2020; 26, 2020. 29, 2020;
29. Chandresakaran B, Ghosh A, Prasad C, Krishnan K and Chandrasharma B. Age and anthropometric traits predict hand grip strength in healthy adults. J Hand Microsurg 2010; 2:58-61.
30. Archana Chahal A, Kumar B Relationship of Hand Anthropometry and Hand Grip Strength in Junior Basketball Boys: 2249-9571: 08/10/2014.
31. Shah, Sirajudeen U, Sherif M, Somasekaran, Mohasin P, Shantaram N, Manjula the Association between Hand Grip Strength and Hand Dimensions in Healthy Indian Females 2012/01/01:36;42 V (4)- International Journal of Current Research and Review
32. Chandna A, Deswal P, Surinder- Hand anthropometric survey of male industrial workers of Haryana State (India) 2011/10/01, 163-82; 9, DO - 10.1504/IJISE.2011.042833 JO - Int. J. of Industrial and Systems Engineering
33. Jarque-Bou NJ, Sancho-Bru JL, Vergara M. A Systematic Review of EMG Applications for the Characterization of Forearm and Hand Muscle Activity during Activities of Daily Living: 2021,26;21(9):3035. doi: 10.3390/s21093035.
34. Fernandez A, Marco, Arreguin R, Juan-Manuel, Gorrostieta-Hurtado, Efren, Ortega P, Carlos J et al., - Methodology Proposal of EMG Hand Movement Classification Based on Cross Recurrence Plots, - 2019,04,12; V: (1) DO - 10.1155/2019/6408941 JO - Computational and Mathematical Methods in Medicine.
35. Razzaque L, Ashrafuzzaman, Study of Age- Related Finger Span and Hand Grip Strength of Adult Female Garment Workers in Bangladesh. 2021; 20:62-6.
36. Shaheen, A.A.M., Omar, M.T.A. & Ali, O.I.Normative values of handgrip and pinch strengths in healthy female college students in Riyadh, Saudi Arabia: a cross-sectional study 2021,26:1:7-7 https://doi.org/10.1186/s43161-021-00019-x
37. Sandhu R, Sandhu p K, Bajaj D, Anthropometric Determinants of Hand Grip Strength in Normal Healthy Punjabis 110.5005/jp-journals-10055- 0016
38. Rawat, S Varte, L. Singh, Singh S, Suchitra Anthropometry based prediction of dominant hand grip strength in Indian office going females 2016/10/31, 58:7; DO- 10.3126/ajms. v7i6.15197 Asian Journal of Medical Sciences

39. Jarque-Bou NJ, Vergara M, Sancho-Bru JL, Gracia-Ibanez V, Roda-Sales A. Hand Kinematics Characterization While Performing Activities of Daily Living Through Kinematics Reduction. IEEE Trans Neural Syst Rehabil Eng. 2020;28 (7):1556-1565. doi: 10.1109/TNSRE.2020.2998642.
40. Ma'touq J, Hu T, Haddadin S. A validated combined musculotendon path and muscle-joint kinematics model for the human hand. Computer Methods in Biomechanics and Biomedical Engineering 2019 22:7, 727-779.
41. Kortier HG, Sluiter VI, Roetenberg D, Veltink PH. Assessment of hand kinematics using inertial and magnetic sensors.2014 21; 11:70. doi:10.1186/1743-0003-11-70 J Neuroeng Rehabil.
42. Morse, Jonathan, Jung, Myung-Chul, Bashford, Gregory, Hallbeck, Susan Maximal dynamic grip force and wrist torque: The effects of gender, exertion direction, angular velocity, and wrist angle 2006,12,01, 737- 742, V:(37), DO- 10.1016/j.apergo.2005.11.008, JO- Applied ergonomics.
43. Farina D, Merletti R, Nazzaro M, Caruso I. Effect of joint angle on EMG variables in leg and thigh muscles. IEEE Eng Med Biol Mag. 2001-20(6):62- 71. doi: 10.1109/51.982277.
44. Pheasant S. Body space: Anthropometry, ergonomics and the design of work. Taylor & Francis; 1996 I: 3; P-352 eBook ISBN9781315375212https://doi.org/10.1201/9781315375212.
45. The majority of US medical students are women, new data show (2019). 25, 2021: https://www.aamc.org/news-insights/press- releases/majority-us-medical-students-are-women-new-datashow.
46. Rash GS, Belliappa PP, Wachowiak MP, Somia NN, Gupta A, A demonstration of validity of 3-D video motion analysis method for measuring finger flexion and extension. 1999;32(12):1337-1341. doi: 10.1016/s0021-9290(99)00140-2.
47. Goubier JN, Mitton LD, Lavaste F, Papadogeorgou E. Normal range of motion of trapeziometacarpal joint. Chir Main 2009; 28: 297-300.
48. Chao EY, Opgrande JD, Axmear FE, Three- dimensional force analysis of finger joints in selected isometric hand functions. J Biomech 1976;9: 387-396 IN2 https://doi.org/10.1016/0021- 9290(76)90116-0.
49. D. Hirsch, D. Page, D. Miller, J.H. Dumbleton, E.H. Miller, A biomechanical analysis of the metacarpophalangeal joint of the thumb, Journal of Biomechanics, V; 1974,4:7:343-48, https://doi.org/10.1016/0021-9290(74)90029-3.
50. Strickland JW. Results of flexor tendon surgery in Zone II. Hand Clinics 1985; 1:167e79.
51. Hume MC, Gellman H, McKellop H, Brumfield RH. Functional range of motion of the joints of the hand. J Hand Surg Br 1990; 15:240e3.
52. Nikanjam M, Kursa K, Lehman S, Lattanza L, Diao E, Rempel D. Finger flexor motor control patterns during active flexion: An in vivo tendon force study. Hum Mov Sci 26:1e10;2007.
53. Lee G, Dexter DJ, Lee TH, Park AE. Subtask analysis of joint angles is key to characterizing surgical movement. Gastroenterology. 2007;132(1):894.
54. Koneczny S, Matern U. Instruments for the evaluation of ergonomics in surgery. Min Invas Ther & Allied Technol. 2004;13:167-177.
55. Gopher D, Donchin E. Workload—an examination of the concept. In: Boff KR, Kaufman L, Thomas J, eds. The Handbook of Perception and Human Performance, Cognitive Processes and Performance. New York, NY: Wiley; Vol 2: 1986.
56. Swanson AB. Flexible implant arthroplasty for arthritic finger joint. J Bone Joint Surg Am 54:435e55;1972.
57. Backer JC, Thakor NV. A study of the range of motion of human fingers with application to anthropomorphic designs. IEEE Trans Biomed Eng35: 110e7; 1998.

58. Degeorges R, Oberlin C. Measurement of three- joint-finger motions: reality or fancy? A three- dimensional anatomical approach. Surg Radiol Anat; 25:105e12;2003.
59. Hamilton R, Dunsmuir RA. Radiographic assessment of the relative lengths of the bones of the fingers of the human hand. J Hand Surg 2002; 27:546–8.
60. Park AE, Fernandez JJ, Schmedders K, et al. The Fibonacci sequence: relationship to the human hand. J Hand Surg 2003; 28:157–60.