International Journal of Advancement in Life Sciences Research

Online ISSN: 2581-4877

Journal homepage http://ijalsr.org

Review Article

Biological Anthropology and Ergonomics – A Review on Indian Scenario

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Abstract

In this review paper, the main objective was to try to find studies relating to augmented reality and virtual reality and the use of ergonomics and anthropology for the betterment of human life by reviewing articles incorporating studies related to ergonomics, human-machine interaction, and increment in functional perspective by using artificial means like artificial neural networks. These works suggest several directions for ergonomics research in India, including the use of virtual and augmented reality. This area is comparatively new while keeping the Indian population in consideration and the use of this methodology, which needs further exploration and research application.

Keywords: Ergonomics, Virtual and Augmented Reality, Anthropometric variables.

Introduction

Ergonomics is a branch of Biological Anthropology that studies human-human and human-nature interaction (Hovenac *et al.,* 2014). Biological anthropology considers humans as organisms with more biological adaptation augmented through cultural modification and inheritance. So the applied part of Biological Anthropology tends to interact with the human body and its responses and coordination in contemporary times. Ergonomics is the study area which focuses on materialistic cultural items altered for more suitability with a particular human organ, which compensates for the biological need. This is a progressive area for the applied sciences. Another research found that day light illumination plays an important role in employee health and thereby adversely affects work productivity (Poddar & Guha, 2021). To understand ergonomics better, the population and its need for compensating biological appliances, as well as the responses regarding those alterations, need to be studied. Modern ergonomics explores such new areas like virtual and augmented reality, where perception of 3D imaging in virtual reality based upon the human body is very much in demand (Gasova *et al.*, 2017). Augmented human imagery within virtual reality to perceive human body interfacing (Kevin *et al.*, 2017) is an intriguing field with far-reaching implications for changing perspectives on human-machine design. There are some other references that consider virtual reality to form an ergonomic industry (Munoz, 2018). As India is a developing country and a niche for a considerable population with a strong gene pool, responses to ergonomically altered appliances can be very unique and variable, with diverse responses. The main objective of this review paper is to extensively compare a few publications based upon their subject and study area selection, responses to certain variables, and their findings, which may pave the way for promising new work sectors focusing on more

accurate and precise research and to throw light on any relevant publications connecting augmented reality and virtual reality with Anthropological Ergonomics studies.

From an evolutionary and daily activity perspective, the anthropologically lower limbs of the human body play a more significant role than other primary locomotion organs and secondary locomotion supportive organs. Because of the cultural inclination to ease human life, sometimes becomes the cause of unnatural alterations like accidental amputations or amputations based on medical reasons and other genetic considerations like mutations, chromosomal aberrations, and teratogenic factors which influence congenital amputations or stunted limb growth. These cases need artificial support systems. Dey and Iqbal (2015) studied "Gait pattern with the use of two different prostheses on amputated limbs in trans-tibial amputees" among five subjects to see the response of two different models of prosthetic lower limb aid. Their main focus for the study was to show that either a more expensive one is functionally better or effectiveness is based upon the body's response to a set by observing multiple variables like foot length, walking speed, stance, and cardiovascular response. This work focused on human biological response to an artificial system while considering the mode of procurement depending upon cultural variables like financial capabilities.

Human resources and labour forces are the building blocks of any community for industry and civilization too. Doing manual labour can cause both physical and mental stress, which can be a communal problem both individually and collectively for the rate and quantity of production within a required time period (Sharma and Majumder, 2021). But from an anthropological viewpoint, factors working as variables, altering workforces while performing the very work, are very phenomenal. From this point of view, Ashraf *et al.* (2015) worked with seven students with no prior experience of manual labour with machines with variable work intensity. They used machine drill work duration and intensity to observe the physiological stress, which can cause problems like musculoskeletal disorders and lower back pain. This study was focused on understanding the discomfort level, which can reduce work efficiency and interest of a worker. In another study, Maulik *et al.* (2015) focused on handgrip strength as an assessment factor for overall physical strength and durability among medical technicians. In this study, they wanted to show that continuous repetitive work with contorted positions for a long time can cause medical problems. They wanted to find if there was any decline rate in handgrip strength, which can be an indicator for preclusive medical disorders. Observing this from a bio-cultural perspective while considering ergonomics' absence or role to have the possibility to alter this situation creates a whole new area of interest anthropologically.

Somatotyping and body shape determination is a method for anthropometric measurements from an applied perspective while estimating body fat content and height-weight ratio can be included. In somatotyping, various methods are used, like BMI estimation and waist-hip ratio with skinfold measurements calculations prescribed by the Heath-Carter method. But new areas and methods of incorporation increase accuracy and the subjects' academic potential. Like Sharma and Majumder (2021) in their "Application of artificial neural network on body somatotype analysis in the Indian population", they wanted to compare between MLP-ANN or Multi-Layer Perceptron Artificial Neural Network and anthropometric body measurements using linear regression. Their observed sample size was 293 subjects (both male and female). They wanted to see the neural network response regarding identifying body morphic somatotypes like endomorph, mesomorph, and ectomorph and their accuracy in correlating. They use ten different parameters for anthropometric measurements, including skin folds. Identifying and applying a more efficient way to determine body type so it can be observed with environmental variation and genetic influence.

There are also some other variables or influences in human daily life which can also trigger a population-level phenomenon which not only has impacts culturally but also biologically too. Handheld devices like these for entertainment, media, and gaming or connectivity purposes can be considered an influencing variable in human society from both a biological and cultural perspective. Due to their being available as cheaper versions to procure and the necessity of their use to be blended into modern life, the use of these categories of instruments increases rapidly. Rajkumar et al. (2015) examined 59 subjects ranging in age from 5 to 56 years old to see if there was a link between MSD

(Musculoskeletal Disorder) and prolonged use of hand-held devices. They studied soft-tissue mobilisation to joint pains in the upper arm area to understand the intensity of the use and a particular device's impact on the human body. They also tested based upon various activities done, like texting and rapid gaming responses. Few studies concentrate on finding a medical-social solution. Shravan and Rajhans (2015) published "Air mattresses as pressure ulcer prevention: An interdisciplinary overview" in 2015. They chose four different mattresses and ten volunteers to understand how two different pressure points work in the human body. Variables like these determine the interaction between cultural and biological perspectives from perspectives like ergonomics, which focus on human behavioural responses based upon ethnicity and biology. Usage of motorcycles is quite frequent in the Indian male population, which can be tested by using DHM, or Digital Human Modelling tool (Arunachalam *et al.,* 2020). This type of application integrates the use of virtual and augmented reality with the field of applied ergonomics.

Considering applications of ergonomics in development, the space programme is also a part of it. And new scientists and scholars are figuring out its implications by using artificial and 3D models in augmented reality. Like in "Space Ergonomics: Analysis of the Artificial Gravity Model and an Improved Proposed Model", it is discussed that preparation for space travel requires training in artificial gravity, which will cause multiple disorders (like loss of muscle mass, tissue damage, osteoporosis, kidney damage, etc.) for prolonged use. So the objective of this research was to find out the basic flaws and propose a new model by using 3D reconstruction in virtual reality for testing (Hussain *et al.*, 2021). Many other works focus on the use of ergonomics to improve human usage and requirements, and it can be applied to computer technology and artificial intelligence, just as the Greeks once did to design better tools and implements (Mustafa *et al.*, 2020). Virtual reality can also be used to create artificial models for autism training and understanding in children. According to one study, using a virtual world to reflect real-world scenarios helps children understand and cohabit in a modern world with minimal risk and traumatic factors, which can overwhelm and change behaviour completely (Piyus *et al.,* 2020).

Methodology

In this review paper we used seven articles published with a focus on ergonomic interaction with an anthropological perspective. Areas of studies were selected based upon human-machine interaction, use of appliances affecting society and alteration of instruments in favour of human use. Our main goal was to learn about the work done under these conditions in an Indian context so that future areas of research can be planned based on the results and population response.

Discussion

In the study of MLP-ANN used to determine the somatotype while comparing it with anthropometric measurements by linear regression, it is found that MLP-ANN accurately determines endomorphs and ectomorphs, but linear regression has better accuracy at mesomorphs. In the whole data set, they found 72 % (approx) of samples processed by MLP-ANN while 27% (approx) became independent. In this study, they incorporated a hidden layer inside this study to understand the linear regression factors affecting Researchers considered this a positive response to the use of MPL-ANN as an artificial neural network for more accurate methods (Majumdar *et al.*, 2015). In the gait pattern analysis, it was found that cheaper models have more positive responses to bodily functions and work efficiency than expensive and complex ones (between the DR and SACH model). So the researchers concluded that the use of expensive models for better work efficiency in developing countries like India can be misleading and use efficiency should be considered (De *et al.,* 2015). In the effect of drilling speed with association with MSD and hand grip usage with association with MSD and LBP, responses to susceptibility to diseases are higher with both age and prolonged exposure to continuous work experience. Use of a drill at 300 rpm for 15 minutes is more strenuous than 700 rpm for 5 minutes, which also decreases the material removal rate (Ashraf *et al.,* 2015). Hand grip usage and strength drop to less than 25.25kgf and 12.5kgf after 40 years for males and 35 years for females

(Dey *et al.*, 2015). Usage of handheld devices affected thumb motions of the left hand more than the right because of motions into extension and flexion of the thumb (Rajkumar *et al.,* 2015). They also said repetitive use can create severe soft tissue and musculoskeletal damage. In this very area of man and material interaction, the use of air mattresses presents a broad spectrum. For example, use of air mattresses has lower chances of preventing PU or pressure ulcers, and antibiotics incorporated into mats can also be considered as part of the study (Shinde & Rajhans *et al.,* 2015). Researchers used 29 anthropometric variables and 20 ROM assessment variables (Range of Motion), but 14 anthropometric and 6 ROM variables are sufficiently interlinked to determine a more appropriate ergonomics structure than more convenient tools such as DHM (Arunachalm et al., 2020). To reduce the stress caused by space travel suitability tests, a better model was developed with a prescribed rotational axis with connector cylinders with less coriolis effect while having the same gravitational force as Earth (Hussain *et al.*, 2021). In the research to create an alternative way using virtual reality to train autistic children, they stated that rather than using real-life training procedures, children more responded towards virtual reality-based games (Voice command recognition, object perception with colour, street crossing module etc.). Even after prolonged use of VR games, children do not respond with a reduced interest in real-life productive activities (Piyus *et al.*, 2020).

Conclusion

From anthropological perspectives, ergonomic studies associated with virtual and augmented reality can be reviewed as a very promising area, and the research done in this area shows a promising future for collaborative work. Man and cultural material interaction were thoroughly observed with biological responses and need-based alterations. We observed that amputees' use of legs can be observed as anthropogenic factors influencing the shape, size, and efficiency of prosthetics while considering expenses as a key factor to keep in consideration. The use of particular machines like hand-held electronic devices and machine handles can also be altered based upon ergonomics specifics to increase work efficiency while reducing the stress and causes of the factors affecting the human body. Incorporating augmented and virtual reality to understand the necessity can be used in these areas of study and more, like designing suitable testing models and devices. As a whole, we can say that Indian sub-continental studies regarding ergonomics have vast prospects for further studies. The use of augmented reality and virtual reality incorporating ergonomics and anthropology is still an area of exploration for further research.

Conflict of Interest

The authors declares that there is no conflict of interest.

Acknowledgment

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