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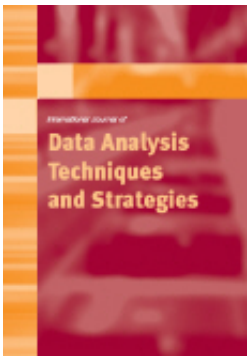

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Analysis of PCS-QoL to investigate the holistic health for sustainable way of living in smart cities of 21st century

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Abstract: Quality of life (QoL) is defined as a standard for well-being of a human being consisting of factors such as comfort, happiness, mental, physical, social, emotional and spiritual health. Today as the countries are growing towards the concept of smart cities and technology, it has become a sole responsibility to bring into notice an analysis of holistic health for sustainable way of living in smart cities of 21st century. In order to examine the QoL of human beings SF-36 questionnaires' has been used. The questionnaire was projected to 500 people belonging to different group of age and a response of 205 people was collected. The dataset is analysed through python libraries such as NumPy, pandas and matplotlib and in the results the variation of PCS value according to gender and profession is plotted, shown and several other parameter variations is analysed. The results predicts about the QoL of people belonging to different age groups, different occupations and different educational backgrounds. Hence, this paper is a perfect model that represents and inspects each and every angle of wellness of human being required for sustainable way of living in the smart cities of 21st century.

Keywords: short form; SF; quality of life; QoL; holistic health; smart cities; sustainable development; physical component summary; PCS; questionnaire; machine learning; data sciences.

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1 Introduction

1.1 Motivation

Life style of people living in 21st century has totally oriented towards materialistic world. People are working relentlessly in order to achieve success, but in this phase of working day and night what mostly people forgot is consequences of this work on their health. Working for 8–10 hours permanently in front of laptop or mobile phone screens by just sitting at one place because many diseases and some of them are weakening of eyesight, headache, diabetes, spinal pain, etc.

To tackle with these problems instead of taking pills and drugs, an ancient Indian practice can be followed which is called yoga and meditation. Yoga and meditation not only maintain our physical health but also proved as a helpful practice to maintain mental peace and hence improve the factors effecting quality of life (QoL). Depression and mental illness can be very well cured with the help of meditation. These increase in various issues regarding physical and mental health motivated the author team to study about scientific effects of yoga and meditation on human body. Thus the author team contributed towards their fundamental responsibility for society and hence provided the results which have shown the QoL of the people living in 21st century.

1.2 Scope of the study

In this study, we will know how the physical and mental exercises along with yoga techniques help in improving the QoL and also, statistically analyse the QoL to investigate the holistic health for sustainable way of living in smart cities. Also we will be able to understand how the alternative therapies and medications are affecting physical and mental health. For this purpose a proper SF-36 questionnaire was prepared and floated among 500 people to analyse the overall health status of the community. The gathered information was then analysed with the advanced algorithms and the author team analysed various aspects such as physical functioning, emotional well-being, social functioning, pain and general health. Our study also tells about some of the other researches done by other authors in this field. Apart from offering an analyses and study to activities improving QoL, our study also leaves space for other readers to read and explore more about the QoL and factors affecting it.

1.3 Topic organisations

The methodology described by author team in which the methods used is machine learning and data analysis. Author team itself collected the data through SF-36 questionnaire. Than the data was analysed using python and machine learning. Further the methodology and experimental requirements are discussed.

In the results and discussion the important highlights of analysis are given and inferences made are discussed. Further in most important section of any research paper that is recommendation section, the suggestions has been made for specific applications to handle the issues and problems identified in the research have been presented. The novelty section gives detail about the unique elements in research. In conclusion section the final assessment and concluding remarks have been given.

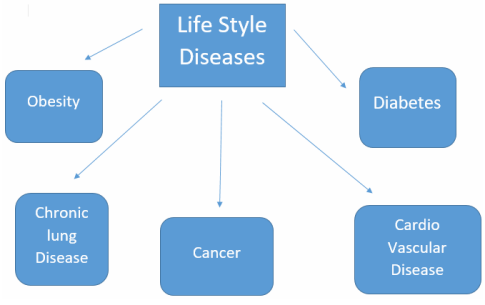
Modern lifestyle has led to poor standard of living and has severely affected the QoL. Lifestyle of 21st century is the cause of many diseases both physical and mental and it is high time that we started thinking about ways to improve our way of living. There are many ways to do so and yoga is one of them. We can also use technologies like AI and ML to analyse and improve the lifestyle, for example various sensors can be used to analyse yoga poses and correct the wrong posture. Besides yoga, meditation can also increase the QoL and is especially effective in mental well-being.

1.4 Health crisis due to 21st century life style

People living in 21st century are more focused on materialistic needs rather than on their physical and mental well-being. This is the reason which is responsible for increase in chronic diseases in past 3–5 decades. Modern lifestyle is responsible for health problems like obesity, lung cancer, decrease in mental health, cardiovascular diseases, chronic obstructive pulmonary disease and diabetes and many more (as per Figure 1). A survey conducted by the Australian institute of Health and Welfare in 2013 found that most deaths in Australia are now caused by chronic disease rather than acute illness, which were the cause of most deaths a hundred years ago (Lifefirstassesment.com, 2022).

Our current lifestyle has also limited our physical strength and it overall affects our efficiency. Modern technology has major impact on physical and mental health, life without smartphones is impossible but on the other hand it has major negative impact on our health such as distraction, expectation of instant gratification and even depression. Nowadays, most of the work which we do is either on laptops or on mobile phones, this has led to inactive lifestyle. Sedentary lifestyle is responsible for obesity and increased cardiovascular diseases. Smoking and alcohol consumption too has very negative impact on our physical and mental health (as per Figure 1) (Quddusi, 2018).

Figure 1 Diseases caused due to modern lifestyle (see online version for colours)



Source: https://www.rroij.com/articles-images-2021/nursing-health-sciences-lifestyle-disease-7-2-2-g001.png

Image depicts the various diseases caused by modern lifestyle. Various diseases like cardiovascular diseases, obesity, chronic lung diseases, cancer, diabetes, etc. are caused by modern lifestyle and the factors include nutrition, inactive lifestyle and intake of various drugs.

1.5 Medications to cure diseases and alternative therapies

Alternative medicine refers to the term that describes medical treatments instead of the traditional therapies. These treatments mainly include herbal medicine, Ayurvedic medicines, mind-body therapies, biological substance-based treatment, manipulative and body-based treatment, energy medicine. In Eastern region, Indian Ayurveda and traditional Chinese medicines are predominantly used whereas in the western part of world, homeopathy and naturopathy are practiced. Alternative medicines can be used to cure various diseases: Ayurveda medicines can cure asthma, anxiety, arthritis, eczema, high cholesterol level and many more. Acupuncture is a therapy that involves inserting

very thin needles in the body. Needles are inserted at different locations to stimulate sensory nerves in the skin and muscles. Mind-body therapies include meditation, prayer, guided imagery yoga, biofeedback and cognitive behavioural therapy. Energy therapies aimed at restoring energetic balance and includes acupressure, Craniosacral therapy, healing touch therapy, polarity therapy and many more (as per Figure 2) (Rastogi et al., 2022; Akter et al., 2021).

Figure 2 Common alternative therapies (see online version for colours)

Source: https://www.verywellmind.com/alternative-therapies-types-and-uses-5207962

Image presents various common alternative therapies to cure diseases easily and without any surgery. These therapies can be performed at home if known well and there is no need to visit doctor clinic on regular basis. The image depicts Ayurveda, meditation, acupuncture, yoga, hypnotherapy and Reiki.

1.6 Variations in yoga practices

It is important to have knowledge about variation of yoga practices to fulfil the desired outcome. There are more than 70 variations that exist for yoga practices but one should know at least some basic variation to keep the body mentally and physically fit. Hatha Yoga is beneficial for beginners as it introduces with different Yoga Asana. It is perform with comparatively slower pace as compared to other yoga poses with a motive to teach the beginners. Bikram Yoga is used to improve sustainability of body in hot climatic regions where temperature rises above 40 degree Celsius. It consist of 26 poses which ensures improvement of breathe and concentration to the body (as per Figure 3).

Figure 3 Ashtanga yoga (see online version for colours)

Source: https://images.onlymyhealth.com/imported/images/2022/June/13_Jun_2022/yoga-for-brain-Main%20(19).jpg

Vinyasa Yoga also known as Ashtanga Yoga is used to improve muscles mass and inner strength of the body. One such example this yoga is Surya Namaskar. Kundalini Yoga is medium to connect body with the spiritual powers. It improves nervous system, sub-consciousness and endocrine system. Anusara Yoga is improve version of Hatha Yoga as it combines asana and those yoga practices that are required to improve sub-consciousness of mind (Thesporting.blog, 2022; Rastogi et al., 2019, 2022).

Figure 3 is showing one of the pose of Ashtanga yoga which is useful in maintaining mental balance and burning body fat.

1.7 Application of AI and ML in physical and mental fitness

In today's lifestyle AI and ML has become almost an inevitable part of human life. Smart devices and applications can be seen for most of the tasks to be performed in daily life. So it would be a better idea to monitor physical and mental fitness using AI and ML applications. There are various applications which are working in this field in order to monitor the sleep cycle, step count, web searches, time spent on mobile phones and daily eating habits in order to draw some results about the physical and mental health of the person. These smart applications can be made more advanced and more accurate by applying some modifications (as per Figure 4) (Rastogi et al., 2019).

An application examining correct Yoga Asana and correct meditating Mudra can be made which will examine the correct posture on the basis of image detection and pattern recognition and thus would complete the need of physical trainer and it would also provide an ease to perform yoga and meditation at anywhere in the world. The application can also include a guide book containing important instructions, reward points to the user as a source of appreciation which may motivate them to perform better, alarm or notification system for reminding the user in case they forgotten. So, AI and ML can play a great role in bringing an ancient scientific practice back into daily practice of today's generation (Chepalov, 2021; Rastogi et al., 2018a).

Figure 4 Examining correct posture using pattern recognition (see online version for colours)

Source: https://www.solutionanalysts.com/wp-content/uploads/2021/07/Body-Specifics-for-Men-and-Women-800x400.jpg

The image describes the correct posture (Yoga Asana) using pattern recognition technique. The image shows that how artificial intelligence and machine learning algorithms can be beneficial for us in bringing the advancement in an ancient Indian practice called yoga. The image clarifies that with the help of AI and ML, the constraint

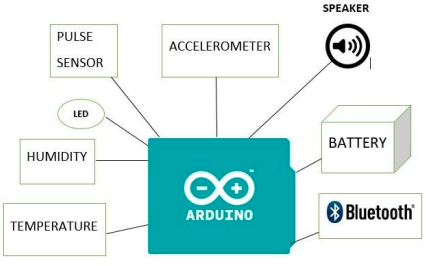
of yoga trainer can be overcome and person will be free to follow it as per his availability of time.

1.8 Different apps and IoT-based sensors to measure effect of yoga and meditation

Because of advancement in technology we are able to measure our mental and physical health more accurately. Sensors nowadays can measure heartbeat, breath rate, pulse and even mental activity. New technologies like machine learning have enabled us to measure continuous human activities like mood changes, emotions and based on that it can give insights about health of that particular person (as per Figure 5) (Rastogi et al., 2021c).

Some real-time embedded kits have also been designed by combining various sensors like DHT-22 (humidity and temperature sensor), ADXL-345 (accelerometer) and HRM-2511E (heart rate sensor) Arduino nano with ATMega 328 microcontroller. It was able to measure the change in reading of various measurements like heartbeat, body temperature, and these all attributes were monitored by using a mobile app. There have been many apps like Daily Yoga, Yoga studio and Pocket yoga is apps which have been used to learn and monitor yoga sessions (Mani et al., 2017; Rastogi et al., 2021d).

Figure 5 Arduino-kit and different parameters to be investigated (see online version for colours)



The image shows how the various sensor units individually combined together with Arduino are used to take readings. Pulse sensor takes pulse data, temperature, humidity take the respective data, this data comes into Arduino and after that from Arduino the data is processed for further stages.

2 Literature review

Here, the author team read some researches made in the related areas and provided a brief description of the data, methodology, results and conclusion. The author team also compiled the insights gained in a tabular form in order to make it easy for readers to get the gist of reviews.

Ahmed et al. in their study in 'Physical activity identification using supervised machine learning and based on pulse rate' focused on identification of physical activities using supervised machine learning model based on pulse rate. For elderly people in physiology, pulse rate is a convenient parameter to identify the physical activity. However, the pulse rate is not exactly same in every individual and varies during activity from person to person. Hence its classification and analysis is a bit difficult. The authors

proposed a case-based reasoning (CBR) approach to identify physical activities of elders based on pulse rate. The supervised machine learning techniques used were support vector machine (SVM) and neural network (NN). The dataset contains 192 pulse rate and three experiments were performed. The experiment result obtained shows that the proposed CBR approach transcends the other two methods. It identified physical activity of elders 84% accurately based on pulse rate (Ahmed and Loutfi, 2013).

Burckhardt et al. (2003) presented the evidence of validation of quality of life scale (QOLS) as an instrument to measure the QoL through exploratory data analysis. It is described in the study that the QOLS was designed by Flanagan in 1970s in the USA. A random sample of 3,000 adults was taken and they were asked questions directly and on the basis of that data collected from the survey the QOLS was developed.

In this study the author team had developed a database from persons of the USA and Sweden with healthy and chronic illness group of both the countries and perform secondary analysis on that database. The dependent features for the analysis were taken from the database maintained by Flanagan. As mentioned in the study, the author team has developed the factor model by performing the exploratory data analyses with orthogonal rotation. The authors had performed analyses on different sets and different combinations of database. On the basis of analyses performed, various factor based conclusions had been drawn which were quite similar to the studies performed earlier with the QOLS on different set of persons belonging to different location and different category. Hence, it is concluded that QOLS is a valid and a reliable instrument for measuring the QoL. Majority of women were white females, on the basis of educational background they belong to middle classes society, this is considered as one of the limitation of the study. It is also mentioned in the study that some additional evidences are needed for the non-whites and the people belonging to different socioeconomic backgrounds to prove the validation of QOLS in this section of population (Burckhardt et al., 2003).

Other renowned researchers also worked on the study of effect of Yoga and Meditation using current technology where they introduced a new angle which relates technology with yoga in order to have command over the health and emotions. Health is state of being physically, mentally and socially fit. It is not just related to the disease but it a broad term that relates to overall well-being of human. Health culture is an ancient culture which consists of medicines, therapy, yoga, meditation, etc. Today yoga has become a most popular way of exercising. The reason behind its popularity is its easiness and scalability as it consists of several poses that can suit to different age groups. Yoga helps in dealing with stress and anxiety. It removes toxin from the body and increase the energy level in the body. Yoga serves eternal happiness and harmony. In the problem statement author states about analysing and validating the effect of yoga on physical and mental health of human beings through data mining algorithms. The dataset has been collected by monitoring the activities of brain of several people through a device named EMOTIVE EPOC before and after performing the pranayama and yoga. The collected dataset was then analysed using a method called as one-way ANOVA. Moreover dataset was also analysed by neurologist and psychologist. A set of questionnaire was also used to study individual response of a person for comparing with the data that was analysed through ANOVA. Based on the comparison of data a model was prepared that can detect a state of emotion of a person so that the person can choose appropriate yoga technique in order to achieve the desired outcome (Scientific Research on Yoga, 2022).

Gill et al. (2013) showed the relationship between QoL and physical activity. The authors' team focuses on participants' views by asking two questions:

1 What is QoL?

2 What is the relationship between the physical activity and QOL?

The definition of QOL differs from individual to individual and the physical activity contributes to emotional well-being, social functioning, physical health and general health. QoL is a key benefit of physical activity. People do physical activity and keep on doing it because it adds values to their QOL. Participants are motivated towards self-determination as they find physical activity fulfils the needs and contribute in enhancing QOL. The enhanced QOL motivates participants and help in creating a positive health cycle. As the definition of QOL is not precise, acts as a barrier to reach the consensus about the relationship between physical activity and QoL.

A QOL survey having two open ended items, 'what is good QoL' and 'how does physical activity contribute to QoL' was completed by a sample of university students and community participants. Then the author team shows the findings from the survey and reflected the views and perceptions of both university students and community participants. The conclusion drawn from the whole is that QOL must be targeted to enhance motivation and creating a positive cycle (Gill et al., 2013).

Hyland et al. has created a new type of global QoL scale which is derived from Borg symptom scales. This scale has four versions which were compared to four category rating (CR) scales and four visual analogue (VA) scales. QoL is a multi-dimensional concept, most of these dimensions are related to specific aspect of person's life but one dimension is global that is person's overall judgement of life.

In this paper subjects were given a scale with numbers 0–100 written on it, 0 was labelled 'perfect QoL' and 100 as 'might as well be dead'. Eight additional quantifiers were used which were: nearly perfect QOL, very good QOL, Good QOL, moderately good QOL, somewhat bad QOL and extremely bad QOL. Subjects were asked to choose the number which best suited the respective quantifier. Subjects were divided into different groups starting from A up to G. Each group consisted of people with various backgrounds and different state of health.

Median position and interquartile range were calculated for each quantifier and group. It was seen that although people differ with regard to position, they assign to a quantifier but the position of median remains same. It was found that position of median is independent of context. In 2nd study, several different global QOL scales were used and then subjects were asked to tell their preference. In 3rd study, the performance of four of the original 12 scales was compared to self-ratings which were examined in study 2.

It was found that the type of rating scale used for survey has small but not trivial effect on the mean rating of global quality of life (GQOL). Different scales affect the consistency with which the people respond to it. H scales produced more consistent results as compared to CR and VA scales. Therefore, Hyland scales which are developed from Borg scales have slightly improved scaling properties as they have additional quantifiers (Hyland and Sodergren, 1996).

Tabular summary has been presented below (Pl. refer to Table 1).

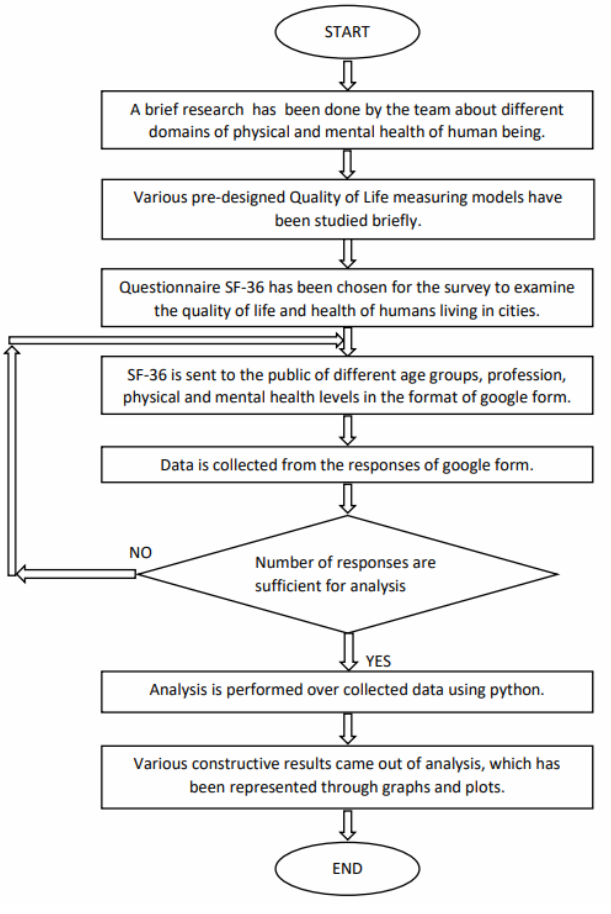
Table 1 Background works and literature reviews

S. no.	*Paper name*	*Summary*	*Methodology, dataset, Algo*	*Concluding remarks*
1	Physical activity identification using supervised machine learning and based on pulse rate.	The author team had focused on identification of physical activities using supervised machine learning model based on pulse rate. The authors proposed a CBR approach to identify physical activities of elders based on pulse rate. The dataset contains 192 pulse rate and three experiments were performed.	The supervised machine learning techniques used were SVM and NN.	The experiment result obtained shows that the proposed CBR approach transcends the other two methods. It identified physical activity of elders 84% accurately based on pulse rate.
2	The Flanagan quality of life scale: evidence of construct validity.	The author team had performed exploratory data analyses over database, various factor based conclusions had been drawn which were quite similar to the studies performed earlier with the QOLS.	Database of persons from the USA and Sweden with healthy and chronic illness group of both the countries, they developed the factor model by performing the exploratory data analyses with orthogonal rotation.	It is concluded that QOLS is a valid and a reliable instrument for measuring the quality of life.
3	The study of effect of yoga and meditation using current technology.	Author introduces a new way by combining technology and yoga together for gaining better results.	EMOTIVE EPOC, ANOVA, data mining algorithms	A model was prepared based on the result that helps a person in selecting the best possible yoga technique for getting desired result.
4	Physical activity and quality of life	Understanding the relationship between physical activity and QOL	Findings by open ended survey filled by a large sample of university students and community participants.	QOL is enhanced by physical activity in multiple aspects
5	Development of a new type of global quality of life scale, and comparison of performance and preference for 12 global scales.	The author team has developed a new type of scale to measure the quality of life and they checked the reliability of new scale.	Subjects were divided into seven different groups on the basis of age, gender and profession. Subjects were given a piece of paper with numbers 0–100 written on it and eight additional quantifiers were written on it. They were asked to position each of quantifiers against the number which best described that quantifier.	It was found that the type of rating scale used for survey has small but not trivial effect on the mean rating of global quality of life. Different scales affect the consistency with which the people respond to it. Therefore, Hyland scales which are developed from Borg scales have slightly improved scaling properties as they have additional quantifiers.

3 Methodology and setup of experiment

This experiment was done by the author's team in order to examine the QOL of the persons living around in the cities. A series of steps have been followed in order to obtain conclusive results. The following flowchart shows the methodology used by the author team (as per Figure 6).

Figure 6 Flow chart of proposed experiment



3.1 The QOLS

The QOLS was manufactured in 1970s by John Flanagan, an American psychologist. The QOLS was developed for use in cases of chronic diseases group; measures of QOLS provided a way to determine the consequences on the health when there is no possibility of treatment of that disease. The QOLS contains various low to medium level interrelations with disease measures and physical health status. The QOL basically measures five conceptual aspects of life and they include physical development and fulfilment, relations with society, physical and mental prosperity, recreation and

independency. Later the QOLS was experimented on various other groups of people and after various researches it was concluded that QOLS is a valid instrument for measuring the QOL.

Flanagan stated that people suffering from chronic disease will have different level of concerns about life or their QOL would be very different and this is noticed to be true when various experiments were performed on different groups of people which may be classified on the basis of disease, region, gender and age. Thus, QOLS can be used to get verified results about QOL with full confidence (Burckhardt et al., 2003; Rastogi et al., 2021f.

3.2 World Health Organization QOL instrument

WHOQOL stands for World Health Organization QOL, is an instrument developed by WHO with an aim to help in assessment of better QOL and may fit to different culture people across the globe. It consists of the use of WHOQOL-100 and WHOQOL-BREF which explains facilitating administration and psychometric properties. WHOQOL-100 focuses on perception of individual related to his/her position with respect to value system and culture. It includes a hundred questions assignment that support 29 different languages. WHOOL-BREF is an abbreviated form consisting of 26 items in the assignment (WHOQOL: Measuring Quality of Life article on WHOQOL, 2022).

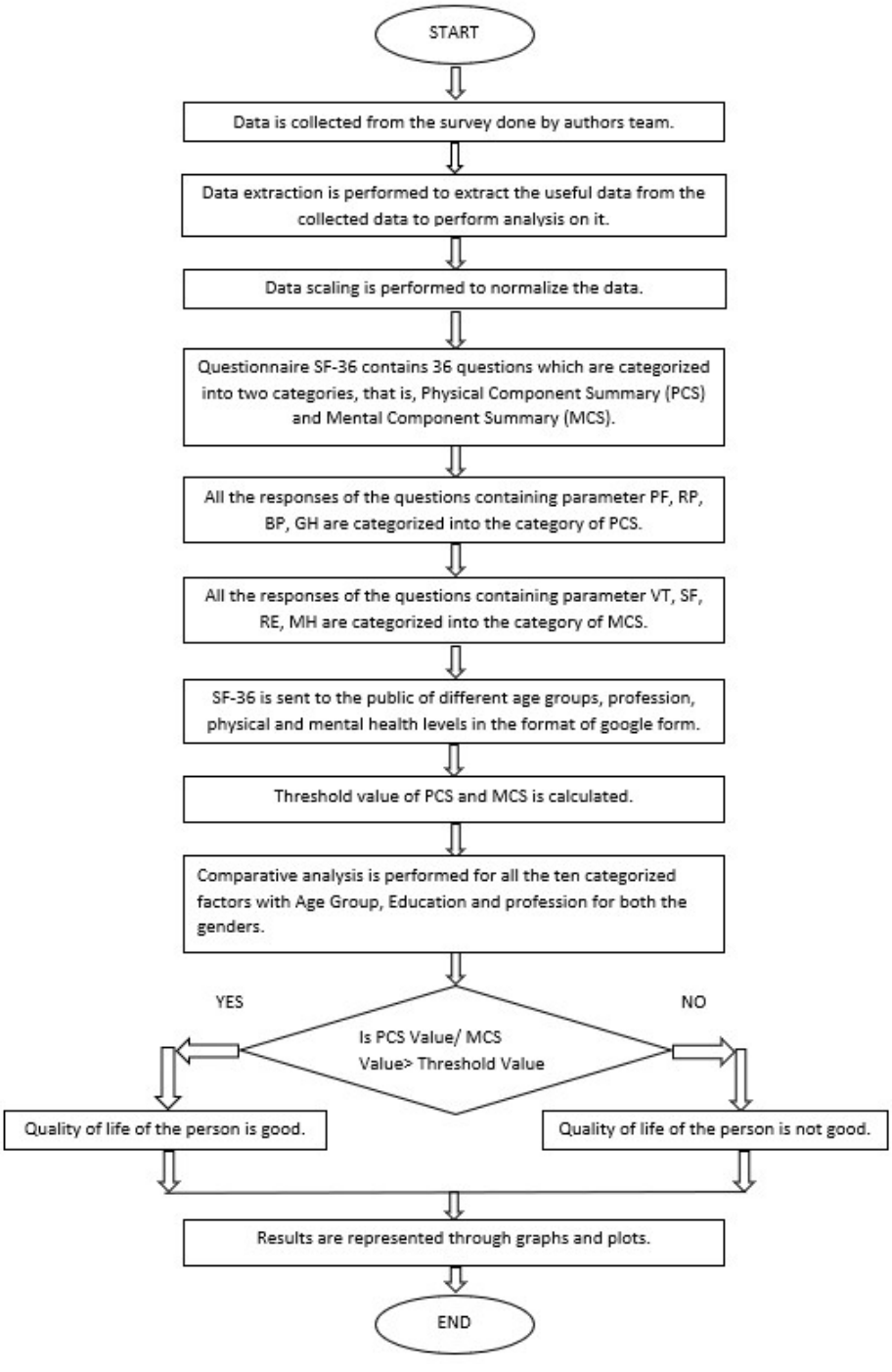
3.3 GQOL scale (1996)

The GQOL is a scale which is derived from the Borg symptom scales. It evaluates QOL by using a rating between 0–100 where 0 means 'no QOL' and 100 mean 'perfect QOL'. In this scale Hyland and Sodergren argued that people can apply their own reasoning to rate themselves when assessing the different aspects of their life. According to them this is more effective approach than adopting a multi-dimensional approach like other questionnaires. The other eight labels are 95 – near perfect QOL, 85 – very good QOL, 70 – good QOL, 57.5 – moderately good QOL, 40 – somewhat bad QOL, 27.5 – bad QOL, 15 – very bad QOL and 5 – extremely bad QOL. These eight labels made it easier to evaluate respondents' QOL (Hyland and Sodergren, 1996).

3.4 SF-36 questionnaire in or proposed approach

Short Form-36 (SF-36) was standardised in 1990. It is a health status profile which was designed to measure the health status of people. It contains 36 questions. The questions reflect eight domains of health which are physical functioning, physical role, pain, general health, vitality, social function, emotional role and mental health. This scale has been found reliable and valid for measuring QOL of individuals who were suffering from chronic health conditions. This scale is being used for several centuries to measure the QOL. This scale can be applied to any age group irrespective of age. The score in SF-36 ranges from 0–100, 100 being the highest. Higher the score better the health status (SF-36 Questionnaire Source, 2022; Rastogi et al., 2018c).

Figure 7 The flow-chart of the physical component summary (PCS) and MCS calculation of QoL of subjects



3.5 Setup and flow chart

The analysis is performed by the researcher team over the collected data by following some of the crucial steps which are represented through the flow chart given below (as per Figure 7).

4 Results and discussion

4.1 Results of PCS calculations

The pie chart represents the male and female ratio of people who took the survey. From the pie chart, it is seen that number of females is more than males (as per Figure 8).

Figure 8 Visualisation of gender (see online version for colours)

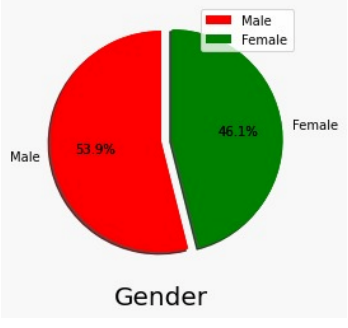
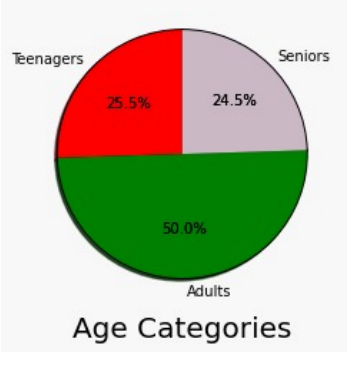


Figure 9 Visualisation of age categories (see online version for colours)



The pie chart represents the age of people who took the survey. From the pie chart, it is seen that nearly half of the population is adults and rest is teenagers and seniors (as per Figure 9).

The pie chart represents the occupation of people who took the survey. From the pie chart, it is seen that there is equal number of students, people who do job, business and those who are unemployed (as per Figure 10).

Figure 10 Visualisation of occupation (see online version for colours)

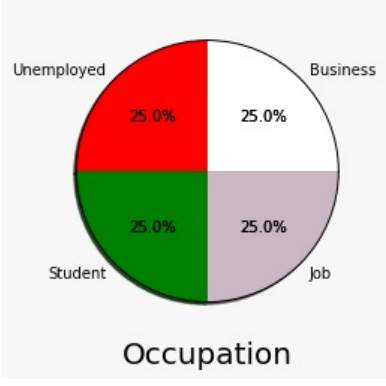
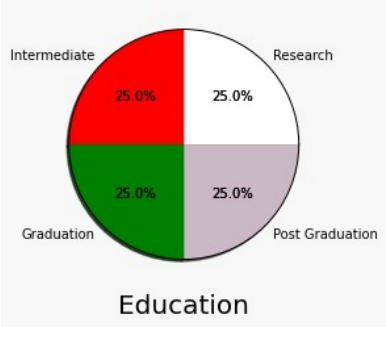


Figure 11 Visualisation of education (see online version for colours)



The pie chart represents the occupation of people who took the survey. From the pie chart, it is seen that there is equal number of people who did graduation, post-graduation, intermediate and research (as per Figure 11).

The bar graph represents number of males and females with different profession, who are having declined physical functioning, i.e., physical functioning score is less than 60. It is seen that maximum number of people who have declined physical functioning are in job. People with other occupation are less in number. In every profession it can be seen that females are less in number (as per Figure 12).

The bar graph represents number of males and females with different age group, who are having declined physical functioning, i.e., physical functioning score is less than 60. It can be seen that in teenagers and middle-aged people number of males is more than females. Number of females is more than males when people above 40 years are considered (as per Figure 13).

The bar graph represents number of males and females with different educational background, who are having declined physical functioning, i.e., physical functioning score is less than 60. It can be seen that number of males is greater than number of females in every educational background. In post-graduation the total number of people with declined physical functioning is maximum (as per Figure 14).

Figure 12 Visualisation of no. of people with declined physical functioning w.r.t gender and profession (see online version for colours)

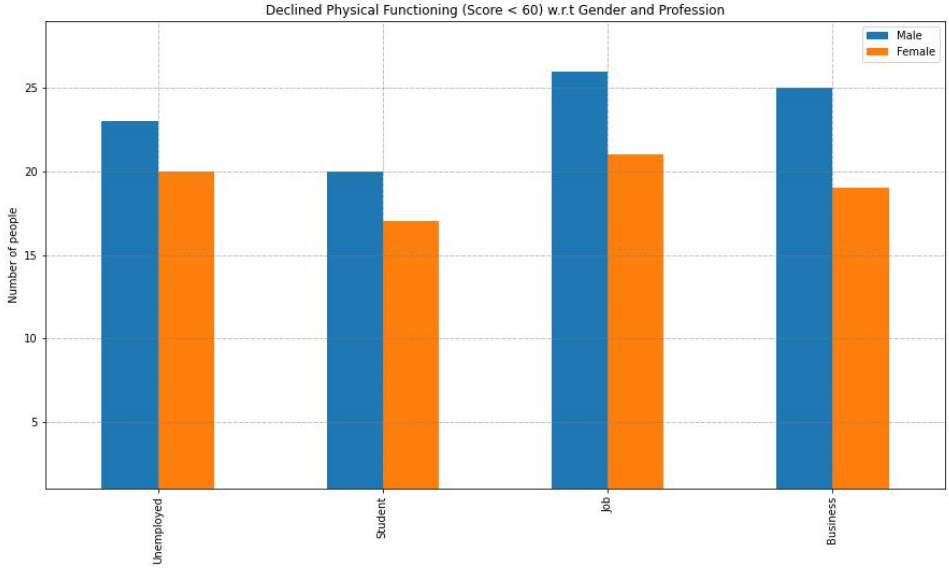


Figure 13 Visualisation of no. of people with declined physical functioning w.r.t gender and age group (see online version for colours)

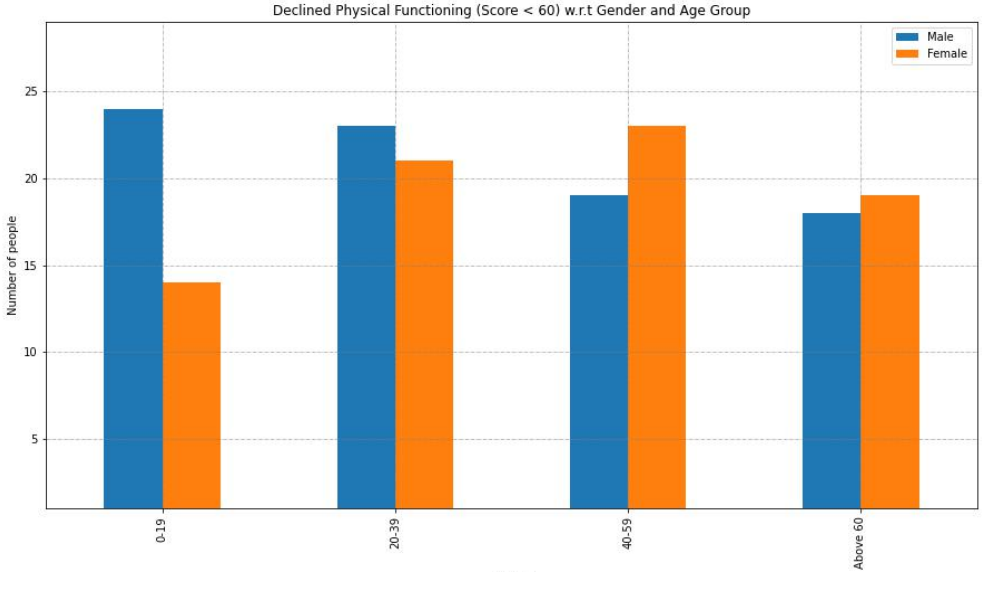


Figure 14 Visualisation of no. of people with declined physical functioning w.r.t gender and education (see online version for colours)

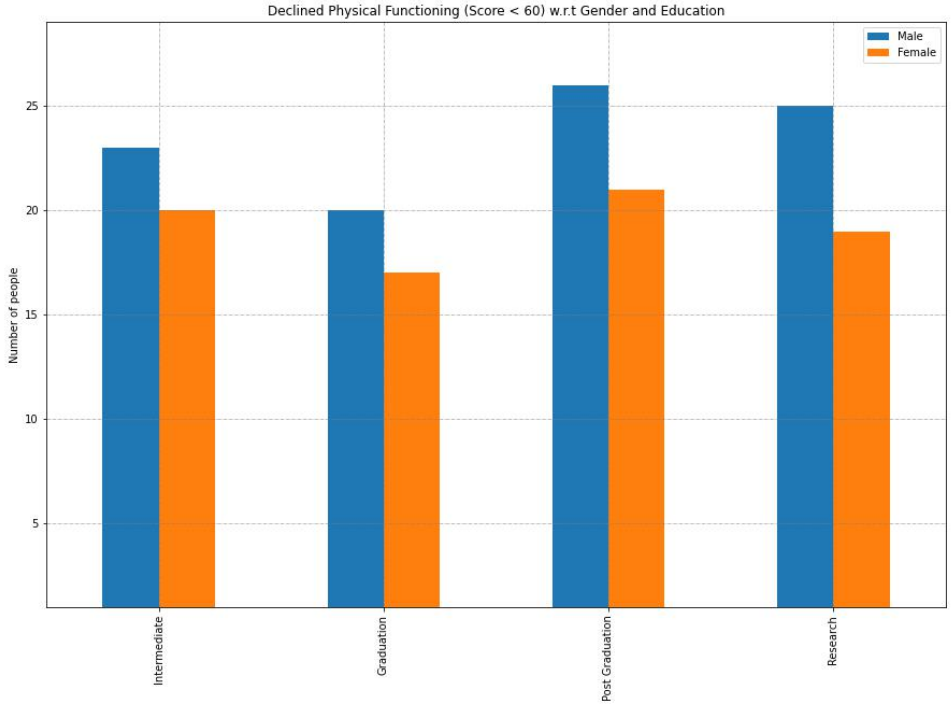
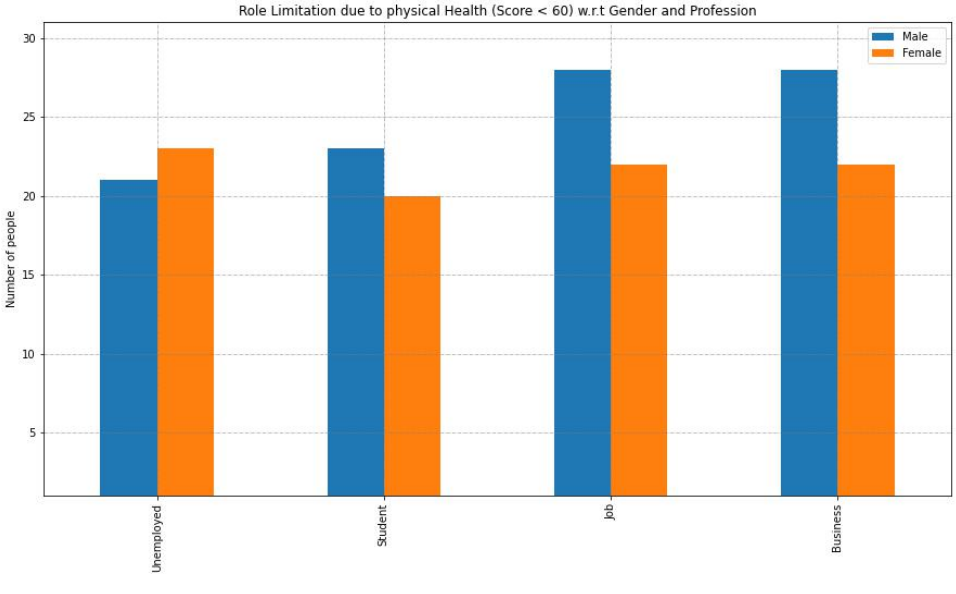
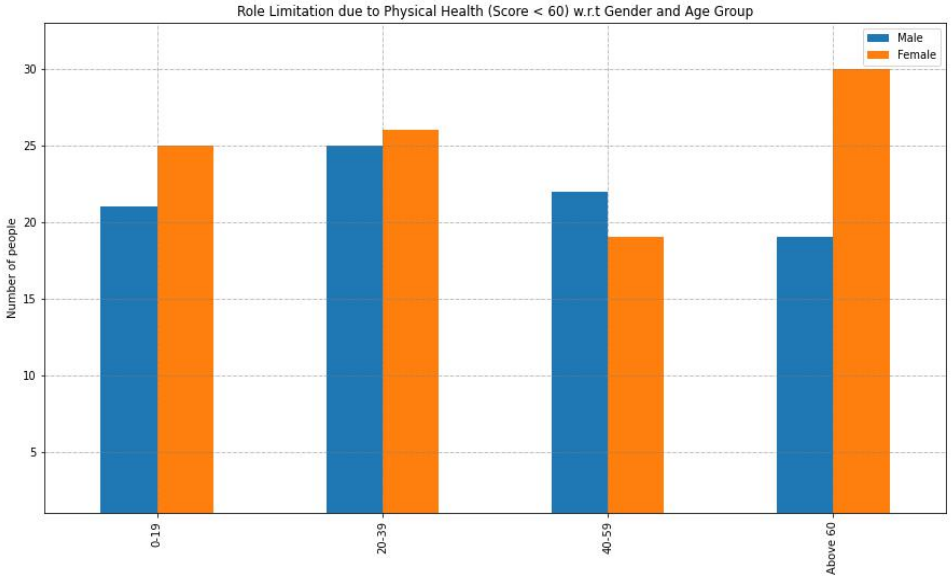


Figure 15 Visualisation of no. of people with role limitations due to physical health w.r.t gender and profession (see online version for colours)



The bar graph represents number of males and females with different profession, who are having role limitation due to physical health, i.e., role limitation due to physical health score is less than 60. It is seen that maximum number of people who have role limitation due to physical health are in job and business. People with other occupation are less in number. In every profession it can be seen that females are less in number except in unemployed category where they are more in number (as per Figure 15).

Figure 16 Visualisation of no. of people with role limitation due to physical health w.r.t gender and age groups (see online version for colours)



The bar graph represents number of males and females with different age group, who are having role limitation due to physical health, i.e., role limitation due to physical health score is less than 60. It can be seen that in teenagers, 20–39 years and in people above 60 years number of females is more than males and in age group of above 60 years this gap is fairly large. In age group 40–59 years number of females is less than number of males (as per Figure 16).

The bar graph represents number of males and females with different educational background, who are having role limitation due to physical health, i.e., role limitation due to physical health score is less than 60. It can be seen that number of males is greater than number of females in every educational background except intermediate. In intermediate the number of females is greater than number of males (as per Figure 17).

The bar graph represents number of males and females in different professions, who are having medium body pain, i.e., body pain score is less than 60. It is seen that maximum number of people who have medium body pain are students. In job and business, it can be seen that there is striking difference in number of males and females having medium body pain (as per Figure 18).

Figure 17 Visualisation of number of people with role limitation due to physical health w.r.t gender and education (see online version for colours)

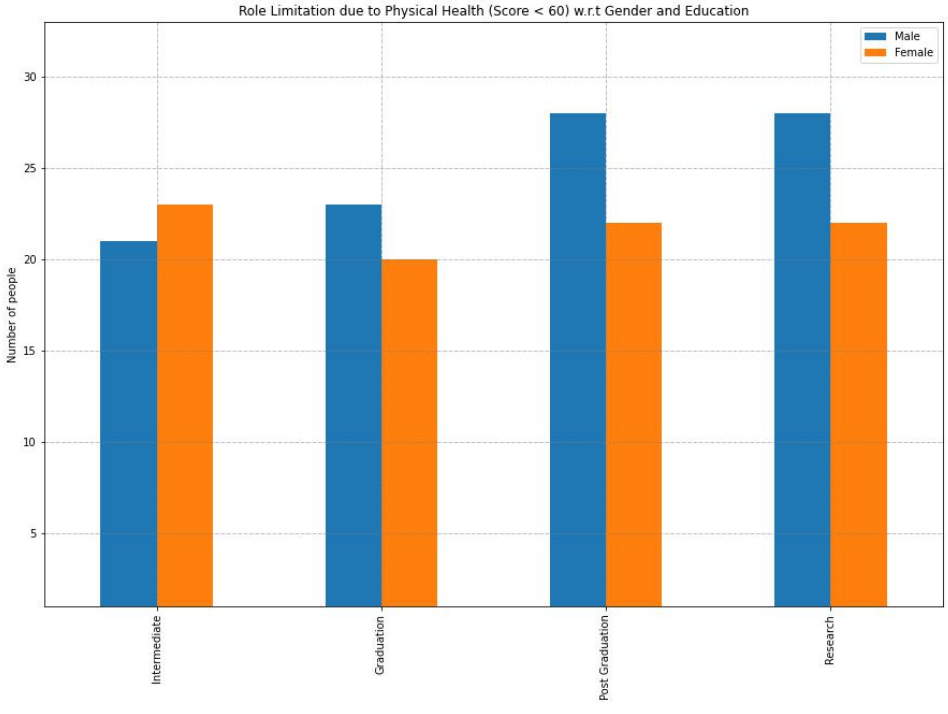


Figure 18 Visualisation of number of people with medium body pain w.r.t gender and profession (see online version for colours)

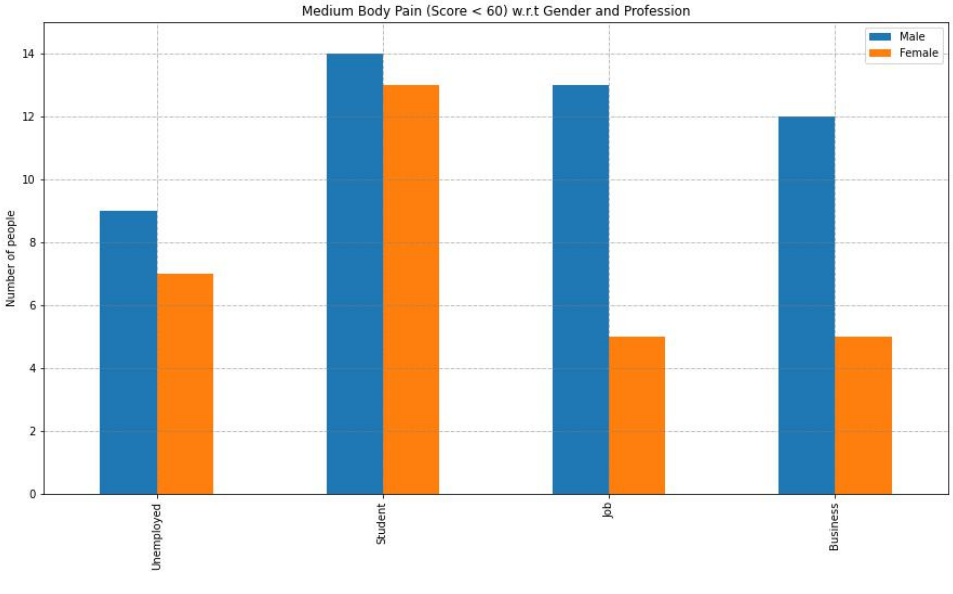


Figure 19 Visualisation of no. of people with medium body pain w.r.t gender and age group (see online version for colours)

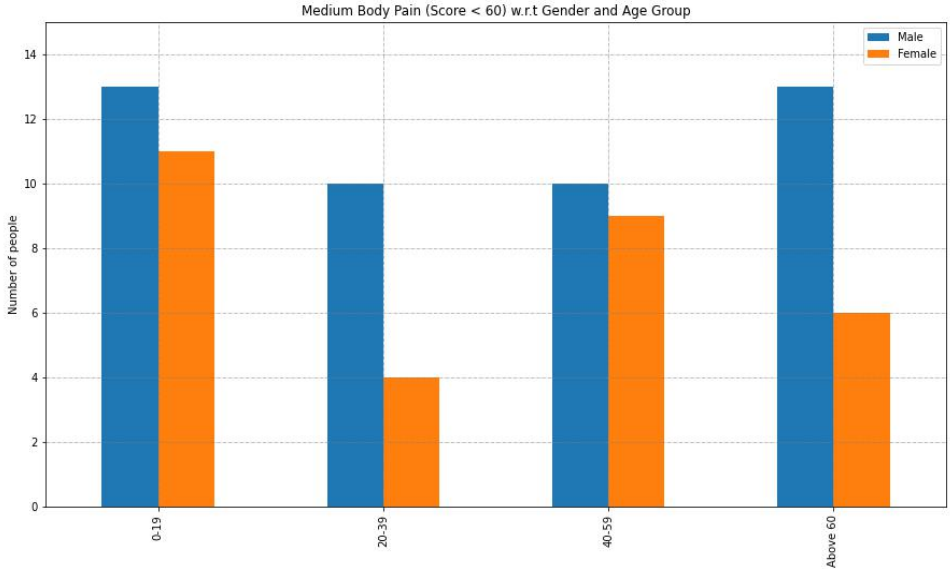
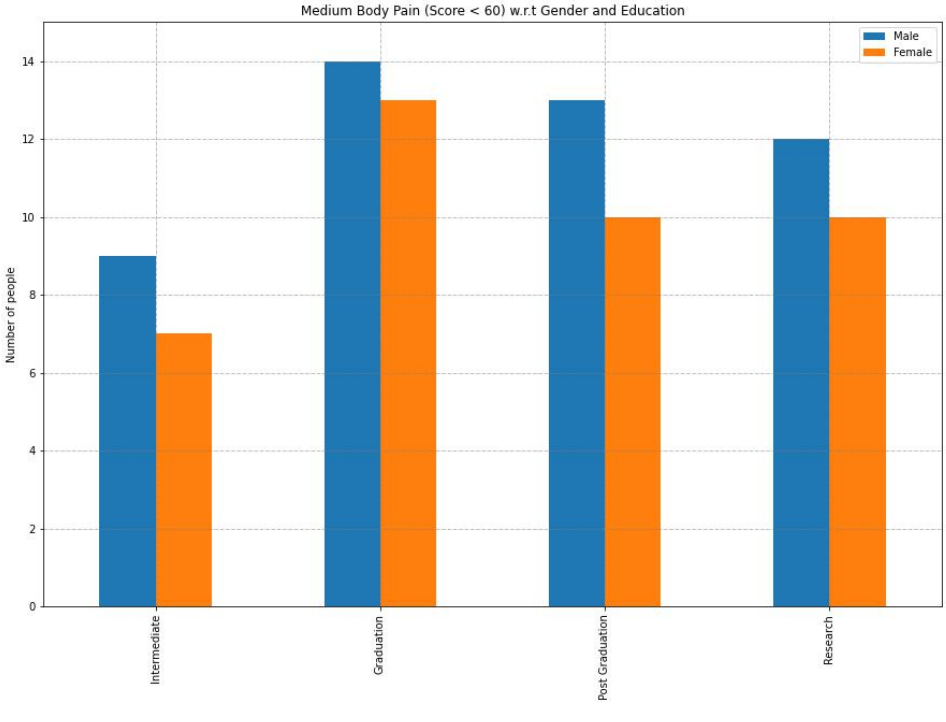


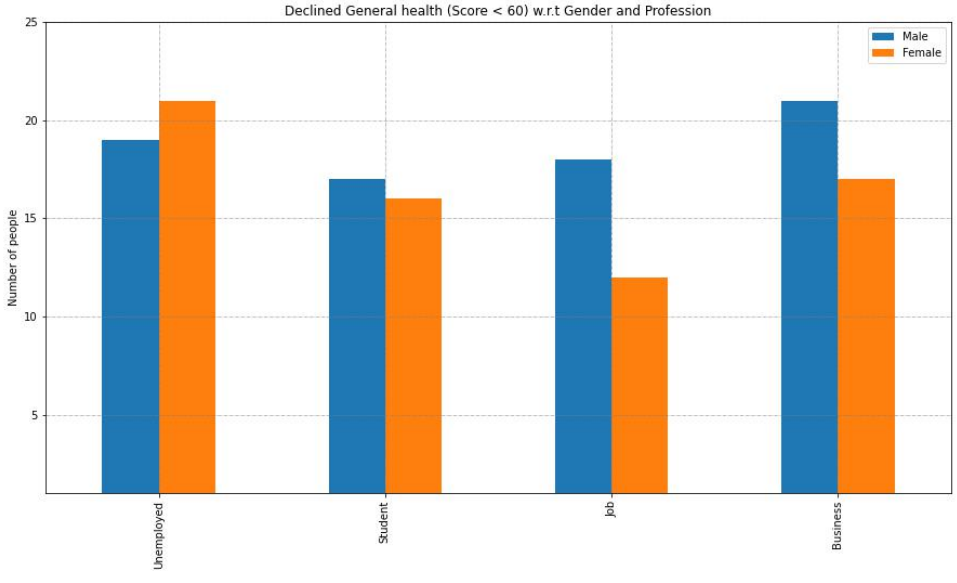
Figure 20 Visualisation of no. of people with medium body pain w.r.t gender and education (see online version for colours)



The bar graph represents number of males and females with different age group, who are having medium body pain, i.e., body pain score is less than 60. It can be seen that number of people who have medium body pain in age group 0–19 years are maximum. In every other age group number of males is more than females (as per Figure 19).

The bar graph represents number of males and females with different educational background, who are having medium body pain, i.e., body pain score is less than 60. It is seen that maximum number of people who have medium body pain are doing graduation. People with other educational background are less in number. Number of females is less in number irrespective of educational background (as per Figure 20).

Figure 21 Visualisation of no. of people with declined general health w.r.t gender and profession (see online version for colours)



The bar graph represents number of males and females with different profession, who are having declined general health, i.e., general health score is less than 60. It is seen that maximum number of people who have declined general health are in unemployed category. People with other occupation are less in number. In every profession it can be seen that females are less in number except in unemployed category where they are more in number (as per Figure 21).

The bar graph represents number of males and females with different age group, who are having declined general health, i.e., general health score is less than 60. It can be seen that number of females in age group above 60 are much more when compared to number of males of same category. In age group 0–19 year's number of males and females are equal. In 20–39 years, number of females is more (as per Figure 22).

The bar graph represents number of males and females with different educational background, who are having declined general health, i.e., general health score is less than 60. It can be seen that number of males is greater than number of females in every educational background. The number of people with declined general health is maximum in research (as per Figure 23).

Figure 22 Visualisation of no. of people with declined general health w.r.t gender and age group (see online version for colours)

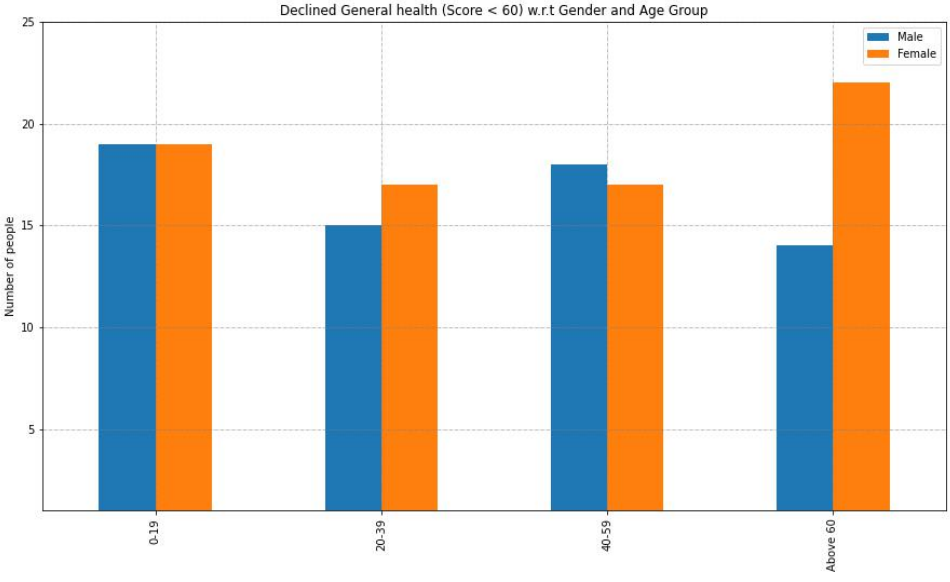


Figure 23 Visualisation of no. of people with declined general health w.r.t gender and education (see online version for colours)

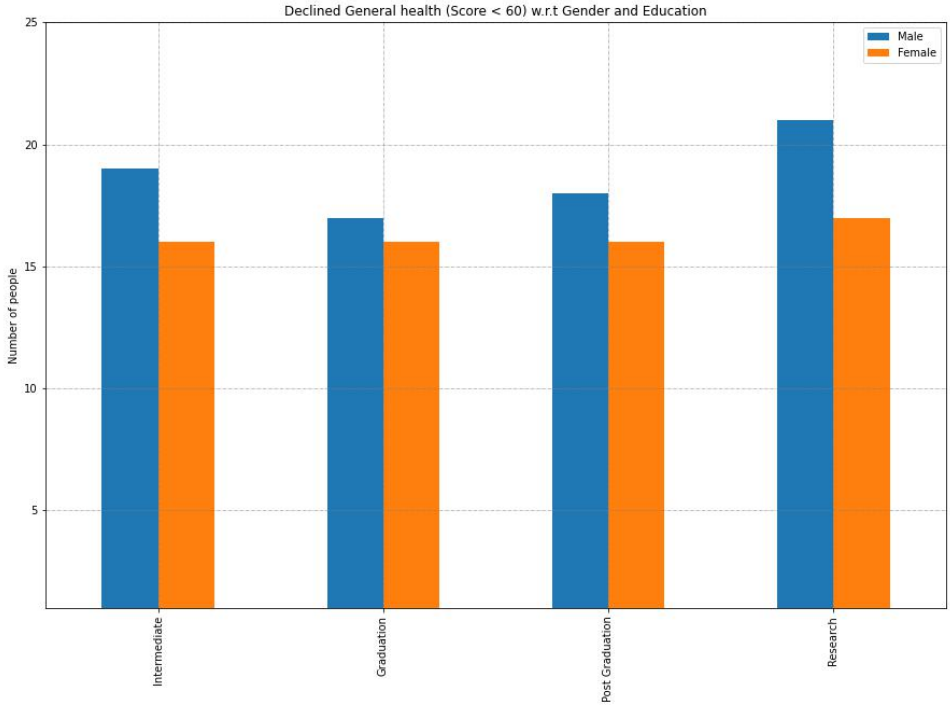
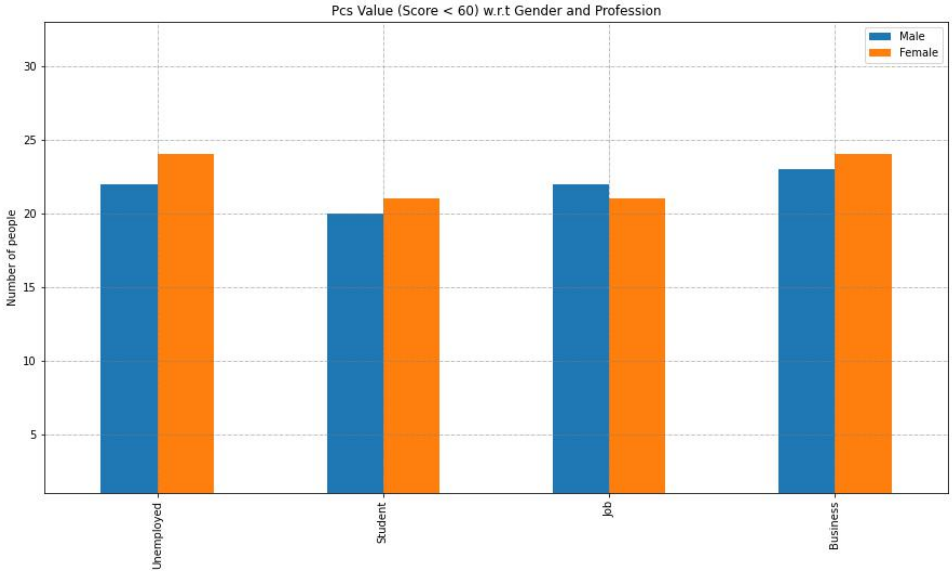
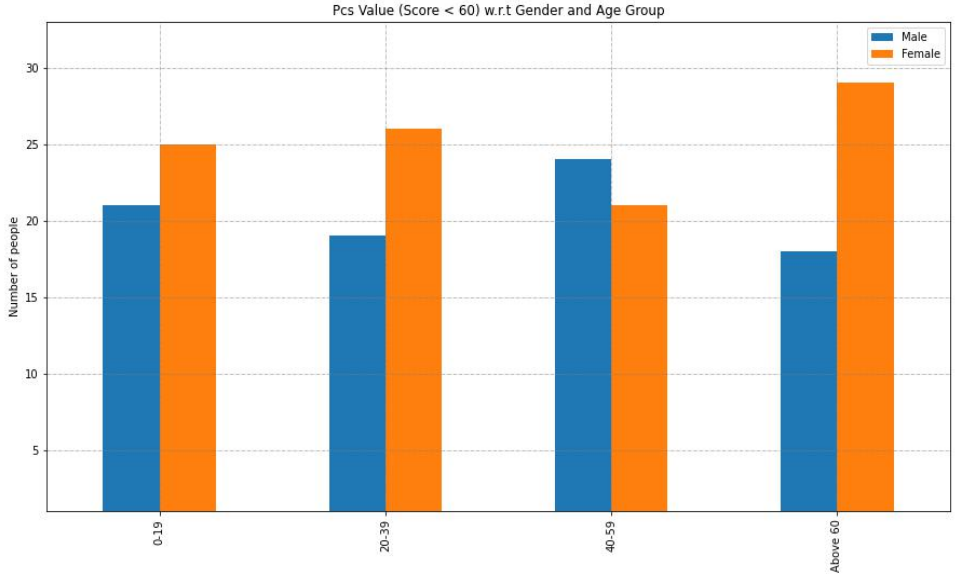


Figure 24 Visualisation of no. of people with less PCS value w.r.t gender and profession (see online version for colours)



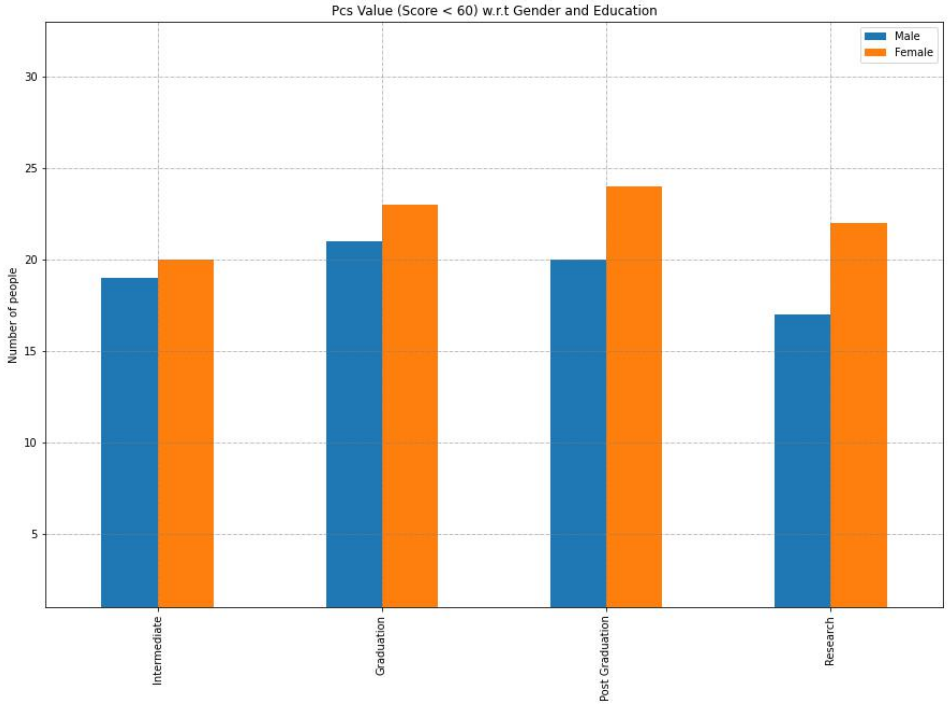
The bar graph represents number of males and females with different educational background, who are having less PCS value, i.e., PCS value score is less than 60. It is seen that in unemployed, student and business the number of females with less PCS value are more as compared to males, whereas in job the number of males is more (as per Figure 24).

Figure 25 Visualisation of no. of people with less PCS value w.r.t gender and age group (see online version for colours)



The bar graph represents number of males and females with different age group, who are having less PCS value, i.e., PCS value score is less than 60. It can be seen that number of females in every age group other than 40–59 years are more when compared to number of males and this gap gets bigger in above 60 yrs. In age group 40–59 years number of males is more (as per Figure 25).

Figure 26 Visualisation of no. of people with less PCS value w.r.t gender and education (see online version for colours)



The bar graph represents number of males and females with different educational background, who are having less PCS value, i.e., PCS value score is less than 60. It can be seen that number of females is greater than number of males in every educational background. The gap in number of males and females increase in post-graduation and people who are doing research (as per Figure 26).

The chart shows the value of mean, median and mode of various parameters which were taken into consideration for analysing data and drawing conclusion. Cronbach's alpha value is also calculated and the negative score of Cronbach's alpha is due to the recoding of scores in parameters. While recoding the author team has taken high scores to denote positive results for example 5 is recoded to 100, therefore the negative value of Cronbach's alpha actually denotes positive results. For the originality of results the author team did not alter the negative scores (as per Table 2).

Table 2 Chart showing reliability, central tendency and variability of scales

	PhysicalFunctions	*PhyHealthLim*	*EmoProbLim*	*Energy/Fatigue*	*EmotionalWellBeing*	*Social functioning*	*Pain*	*GeneralHealth*	*PCS value*	*MCS value*
Count	204	204	204	204	204	204	204	204	204	204
Mean	31.470588	35.60049	35.375817	50.214461	47.328431	48.161765	69.252451	52.941176	47.316176	45.270118
Std.	26.064417	20.757462	23.305645	10.275977	8.500651	14.722082	23.537754	10.489332	9.370674	8.168269
Min	0	0	0	12.5	25	0	0	20	25	22.5
25%	5	25	22.91667	43.75	40	37.5	55	45	40	39.973958
50%	30	37.5	33.333333	50	45	50	68.75	50	46.875	44.583333
75%	50	50	50	56.25	55	50	90	60	52.578125	50
Max	100	100	100	81.25	90	87.5	100	85	78.75	79.0625
Alpha	0.910049	0.7289	0.793	–0.57	–0.94	-1.22533	0.72	–0.14	–0.35	0.16

4.2 Discussion on PCS

From the results obtained from the data we can see clearly that irrespective of their age group, educational background and profession approximately same numbers of people are having less PCS value. If we focus on profession than we can see that there are same numbers of males and females in each category, (i.e., unemployed, student, job and business) who have less PCS score, while this is not true in case of age group and education. In both education and Age group there are more number of males and less number of females.

The results clearly those males are more dissatisfied with the quality of their life. There may be various factors responsible for this, like in case of age group males between age of 20–39 years and above 60 years are very large in number and there is also significant difference between the number of males and females in terms of less PCS score this may be because of the activities they perform in that age (20–39) or because of not having someone to look after them. In terms of profession we can see that there are comparatively less number of male and female with respect to other divisions.

5 Novelties

- This research document analyses various techniques which can be used to improve QOL.
- After doing the analysis of data the author team found out that people who are physically active have better QOL in physical, social and mental aspect.
- The author team has used PCS values and plotted various graphs taking these two values in consideration and found that people having higher values of these have better QOL (Rastogi et al., 2021a, 2021b, 2021e).

6 Recommendations

1 One should exercise daily to keep oneself healthy and fit (Rastogi et al., 2018b).

2 One should have right knowledge while performing any exercise to ensure desire result.

7 Future research directions and limitations

7.1 Limitations

- Authors' team may have less data set for analysis.
- Data set received may be not that accurate.

7.2 Future directions

- The inclusion of proper variables and invariables with the remedy to prevent their effects on the experiments should be taken into prior considerations.
- Ensuring data set received should be accurate and most suitable algorithm should be implemented to analyse the data set.

8 Conclusions

The above studies show that that the QOL is greatly influenced by physical activities. The results obtained shows that the people engaging in physical activities are happier, more active and live a healthy life. Living in healthy, fresh and unpolluted environment makes a person physically, mentally and socially well-being. Apart from that it has been observed that people with more involvement in physical activities (sports, yoga and meditation) are more satisfied with QOL they live. Some methods suggested by author team for remaining physically and mentally active are yoga and meditation. Yoga and meditation not only help us to keep our body fit but, also rejuvenates heart and soul. Sports activities are also a good and engaging way to keep one healthy.

In this research paper, the author's team collected data with the help of SF-36 questionnaire and then analysed the data by categorising responses obtained in eight categories. After which the eight categories obtained are further mapped into two main components which are PCS and MCS. These values helped us to draw a conclusion about QOL of people of people belonging to different age groups, different occupations and different educational backgrounds. The results obtained are represented through appropriate graphs.

Ethical Committee and Funding

The experiment does include human related experiments but it is ensured that no ethical constraints should be violated. Since the research work is related to the health of humans, thus their data has been collected by the author's team but it is ensured that the study does not violate any ethical laws. The research work only works upon the data collected through the survey; rather there was not any experiment which is directly performed on human beings. The project is not funded by any agency.

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Key terms and definitions

- *Yoga:* yoga is a group of physical, mental, and spiritual practices or disciplines which originated in ancient India and aim to control and still the mind, recognising a detached witness-consciousness untouched by the mind and mundane suffering.
- *Meditation:* meditation is a practice in which an individual uses a technique – such as mindfulness, or focusing the mind on a particular object, thought, or activity – to train attention and awareness, and achieve a mentally clear and emotionally calm and stable state. Meditation is practiced in numerous religious traditions.
- *Fitness:* fitness is a state of health and well-being and, more specifically, the ability to perform aspects of sports, occupations and daily activities. Physical fitness is generally achieved through proper nutrition, moderate-vigorous physical exercise, and sufficient rest along with a formal recovery plan.

- *QoL:* quality of life is defined by the World Health Organization as ‘an individual’s perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns’.
- *Mental peace:* mental peace refers to the deliberate state of spiritual calm and the potential of stressors such as the burden arising from pretending to perform at an optional level with a positive mind (inner peace). Peace of mind is generally associated with joy, happiness, calmness, prayer, yoga, meditation, etc. many spiritual practices refer to this peace as an experience of knowing oneself.
- *Indian culture:* Indian culture is the heritage of social norms, ethical values, traditional customs, belief systems, political systems, artefacts and technologies that originated in or are associated with the ethno-linguistically diverse Republic of India. The term also applies beyond India to countries and cultures whose histories are strongly connected to India by immigration, colonisation, or influence, particularly in South Asia and Southeast Asia. India’s languages, religions, dance, music, architecture, food and customs differ from place to place within the country.
- *Human health:* health, according to the World Health Organization, is ‘a state of complete physical, mental and social well-being and not merely the absence of disease and infirmity’.

Annexure

Data sets

Table A1 Sample dataset-1 with column 1–7

−1	−2	−3	−4	1	2	3	4	5	6	7
Gender	*Age*	*Education*	*Profession*	*Health condition*	*Comphealth*	*VigActive*	*ModActive*	*Lifting*	*SeveralStairs*	*OneStair*
1	20	2	2	3	4	2	3	3	3	3
1	20	2	2	3	2	2	3	3	2	3
1	21	2	2	2	3	2	2	2	2	2
1	21	2	2	4	4	2	2	2	3	2
0	20	2	2	2	3	2	2	3	2	3
1	20	2	2	3	5	3	3	3	3	3
1	21	2	2	3	4	2	3	3	3	3
1	20	2	2	4	4	2	3	2	2	2
0	21	2	2	3	2	2	2	1	1	1
0	20	2	2	4	4	3	3	3	2	2
1	21	2	2	4	5	3	3	3	3	3
1	45	3	3	3	2	2	3	3	3	2
1	21	2	2	3	4	2	3	3	3	3
1	20	2	2	3	2	2	1	2	2	3
1	21	2	2	3	3	2	3	3	3	3
0	35	2	3	2	3	2	1	3	2	3
0	26	2	3	4	4	3	3	3	2	3
0	34	3	2	4	4	1	3	2	1	1
0	33	2	3	2	3	2	3	3	2	3
0	46	3	2	4	3	1	1	1	1	1
1	21	1	2	4	2	2	2	3	2	2
1	20	2	2	4	3	3	3	3	3	3
1	19	2	2	4	3	3	3	3	3	3
1	24	2	3	2	3	1	2	3	3	3
0	45	4	4	4	3	3	3	3	3	3
1	55	4	4	4	4	3	3	3	3	3
0	31	4	3	5	3	3	3	3	3	3
0	33	3	3	5	5	2	2	2	3	3

Table A2 Sample dataset-2 with column 8–17

8	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*
BNKmove	*MoreMile*	*SevhundredYards*	*OnehundredYards*	*SelfBoD*	*CutworkNactTimeE*	*LessAccomplishE*	*LimOtherActivitiesE*	*ProbWorknActE*	*CutworkNactTimeE*
3	3	2	3	3	4	4	5	4	4
3	3	3	3	3	3	2	3	2	4
2	2	2	2	2	3	3	3	3	3
3	2	2	2	3	4	4	5	4	4
2	2	2	3	3	4	3	4	4	3
3	3	3	3	3	2	2	3	4	4
3	3	2	3	3	4	3	4	4	5
2	2	2	2	2	4	4	4	4	4
1	2	1	1	1	4	3	4	2	4
2	1	1	1	1	1	1	1	1	3
3	3	3	3	3	5	5	3	5	5
2	2	3	3	2	3	4	3	4	3
3	3	3	3	3	4	3	3	4	3
2	1	2	1	1	2	3	4	4	2
3	3	3	3	3	3	4	4	5	4
2	2	2	2	2	3	4	4	4	4
3	3	2	2	3	4	5	5	4	4
2	2	2	2	1	2	2	3	5	4
2	3	3	3	3	4	3	2	2	2
1	1	1	1	1	3	3	3	3	3
2	2	1	2	1	1	1	1	1	1
3	3	3	3	3	4	3	4	5	4
3	3	3	3	3	4	3	4	5	4
3	2	2	3	3	4	3	3	4	1
3	3	3	3	3	2	4	4	4	5
3	3	3	3	3	4	3	4	4	4
3	3	3	3	3	5	5	5	5	5
3	3	3	2	3	4	4	5	4	4

Table A3 Sample dataset-3 with column 18–27

18	19	20	21	22	23	24	25	26	27
LessAccomplishE	*LessCareWork*	*PnEInterferenceSA*	*BodyPain*	*PainInterference*	*LifeFull*	*Nervous*	*FeltDown*	*CalmNPeaceful*	*LotEnergy*
4	4	4	5	5	5	4	5	4	4
3	3	3	6	5	3	4	3	3	1
3	3	3	4	3	3	3	3	3	3
4	5	4	6	5	4	4	4	4	4
3	3	3	2	3	2	3	3	3	3
3	4	4	6	5	4	4	5	4	3
4	4	5	6	5	4	4	5	4	4
4	4	4	6	5	5	5	4	4	4
3	4	1	4	2	3	2	4	3	3
3	3	3	3	3	3	3	3	3	3
4	4	2	5	5	3	4	4	4	4
2	4	5	2	4	3	4	3	4	4
2	4	4	6	5	3	3	3	4	3
2	3	1	3	3	1	2	3	1	2
4	4	3	4	3	4	4	5	4	4
4	4	4	3	3	2	3	3	2	3
5	5	4	5	5	5	4	5	4	4
4	3	3	5	5	3	3	3	1	3
2	2	1	3	3	2	2	2	1	3
3	3	5	5	3	5	3	3	3	3
4	3	2	5	3	4	2	3	3	2
3	3	4	6	4	4	3	4	4	4
3	3	4	6	4	4	3	4	4	4
1	1	3	1	4	3	2	2	2	2
5	5	5	6	5	2	2	2	2	2
4	4	4	2	4	4	4	2	4	3
5	5	5	5	5	5	5	5	5	5
3	5	4	5	5	5	5	4	4	4

Table A4 Sample dataset-4 with column 28–36

28	29	30	31	32	33	34	35	36
DepNDownheart	*WornOut*	*BeenHappy*	*FeelTired*	*PnEInterferenceSO*	*SickEasier*	*CompHealthy*	*ExpWorse*	*ExceHealth*
5	5	5	3	4	3	4	5	4
2	2	3	2	3	4	4	4	3
3	3	3	3	3	3	3	3	3
3	4	4	4	4	4	4	4	4
3	3	3	3	3	3	3	3	3
2	3	2	4	5	4	5	4	4
5	5	4	4	4	4	4	5	4
4	4	3	4	4	4	4	5	5
4	3	3	2	3	2	3	3	2
3	3	3	3	3	3	3	3	2
4	4	4	4	4	5	3	4	4
3	4	4	4	4	4	2	2	4
4	4	4	4	4	5	3	3	4
1	3	2	2	3	3	3	2	3
4	5	4	4	3	5	4	4	4
2	3	3	3	2	2	1	5	2
4	5	5	4	4	3	3	5	4
3	3	3	4	4	5	3	3	4
3	3	2	2	2	2	2	3	1
5	5	3	4	5	5	5	5	4
5	2	1	1	3	2	4	3	4
3	3	4	3	5	3	3	5	4
3	3	4	3	5	3	3	5	4
1	2	3	2	2	2	2	5	2
3	5	3	5	5	4	4	4	4
1	1	1	1	1	2	3	2	4
5	5	5	5	5	5	5	5	5
4	4	4	3	4	5	3	5	5

Table A5 Sample dataset-5 with eight derived features

37	38	39	40	41	42	43	44
Physical functions	*PhyHealthLim*	*EmoProbLim*	*Energy/fatigue*	*Emotional wellbeing*	*Social functioning*	*Pain*	*General health*
10	18.75	25	56.25	40	50	90	50
10	62.5	41.66666667	50	50	50	100	45
50	50	50	50	50	50	55	45
35	18.75	16.66666667	50	50	50	100	55
30	31.25	50	43.75	50	50	35	45
0	56.25	33.33333333	50	40	37.5	100	55
10	31.25	16.66666667	43.75	35	62.5	100	45
45	25	25	56.25	35	50	100	55
85	43.75	33.33333333	56.25	45	25	42.5	50
55	100	50	50	50	50	45	50
0	12.5	16.66666667	43.75	45	25	90	45
25	37.5	50	43.75	55	62.5	47.5	50
5	37.5	50	37.5	55	50	100	45
65	43.75	66.66666667	37.5	50	25	45	55
5	25	25	43.75	40	50	55	45
45	31.25	25	43.75	50	75	45	25
15	12.5	8.333333333	50	45	50	90	50
65	50	33.33333333	43.75	40	37.5	90	50
15	56.25	75	50	45	37.5	45	35
100	50	50	43.75	40	50	65	50
55	100	58.33333333	68.75	35	37.5	65	70
0	25	41.66666667	62.5	55	37.5	87.5	50
0	25	41.66666667	62.5	55	37.5	87.5	50
25	37.5	100	56.25	65	62.5	37.5	30
0	37.5	0	12.5	55	50	100	55
0	31.25	25	81.25	55	87.5	47.5	70
0	0	0	50	40	50	90	60
20	18.75	25	62.5	40	50	90	50

Snapshots of coding

Figure A1 Coding snippet for pie graph representing various occupational categories (see online version for colours)

```
labels = 'Unemployed', 'Student', 'Job', 'Business'
sizes = [u, s, j, b]
colors = ( "red", "green", "#cab8c4",
          "white")

fig1, ax1 = plt.subplots()
explode = (0, 0, 0, 0)
font = {'family': 'serif',
        'color':  'darkred',
        'weight': 'normal',
        'size': 20,
        }
plt.xlabel("Occupation",loc="center",fontsize=20)
ax1.pie(sizes, colors = colors, explode=explode, labels=labels,autopct='%1.1f%%', shadow=True, startangle=90,wedgeprop
                        'linewidth': 2,
                        'antialiased': True})
patches, texts, auto = ax1.pie(sizes, colors=colors, shadow=True, startangle=90,explode=explode, autopct='%1.1f%%' )

plt.show()
plt.savefig('Occupation_per.jpeg')
```

Figure A2 Coding snippet for bar graph showing medium body according to gender and professions (see online version for colours)

Bar graph showing Medium body pain accoring to gender and professions

```
plotdata = pd.DataFrame({

    "Male":[9,14,13,12],

    "Female":[7,13,5,5]},

    index=["Unemployed", "Student","Job","Business"])
y=[1,2,3,4,5,6,7,8,9,10,11,12]
#y=[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20]
plotdata.plot(kind="bar",figsize=(15, 8))

plt.title("Medium Body Pain (Score < 60) w.r.t Gender and Profession")
plt.xlabel("Profession")
max_ylim = max(y) + 3
min_ylim = min(y) -1
plt.ylim(min_ylim, max_ylim)
plt.ylabel("Number of people")
plt.grid(b = True, color ='grey',
        linestyle ='-.', linewidth = 0.5,
        alpha = 1)

plt.savefig("Pain_Profession.jpg")
```

Figure A3 Coding snippet for bar graph showing variation of PCS value according to gender and profession (see online version for colours)

Bar graph showing variation of pcsvalue accoring to gender and Profession

```
plotdata = pd.DataFrame({

    "Male":[25,25,28,26],

    "Female":[25,24,23,21]},

    index=["Unemployed", "Student","Job","Business"])
#y=[1,2,3,4,5,6,7,8,9,10,11,12]
y=[2,4,6,8,10,12,14,16,18,20,22,24,26,28,30]
plotdata.plot(kind="bar",figsize=(15, 8))

plt.title("Mcs Value (Score < 60) w.r.t Gender and Profession")
plt.xlabel("Profession")
max_ylim = max(y) + 3
min_ylim = min(y) -1
plt.ylim(min_ylim, max_ylim)
plt.ylabel("Number of people")
plt.grid(b = True, color ='grey',
        linestyle ='-.', linewidth = 0.5,
        alpha = 1)

plt.savefig("mcsvalue_Profession.jpg")
```

Figure A4 Coding snippet for bar graph showing less vitality according to gender and educational background (see online version for colours)

Bar graph showing Less Vitality accoring to gender and educational backgrounds

```
plotdata = pd.DataFrame({

    "Male":[22,21,25,22],

    "Female":[21,22,19,18]},

    index=["Intermediate", "Graduation","Post Graduation","Research"])
#y=[1,2,3,4,5,6,7,8,9,10,11,12]
y=[2,4,6,8,10,12,14,16,18,20,22,24,26,28,20]
plotdata.plot(kind="bar",figsize=(15, 10))

plt.title("Less Vitality (Score < 60) w.r.t Gender and Education")
plt.xlabel("Education")
max_ylim = max(y) + 3
min_ylim = min(y) -1
plt.ylim(min_ylim, max_ylim)
plt.ylabel("Number of people")
plt.grid(b = True, color ='grey',
        linestyle ='-.', linewidth = 0.5,
        alpha = 1)

plt.savefig("Vitality_Education.jpg")
```

Figure A5 Coding snippet for bar graph showing variation of MCS value according to gender and educational (see online version for colours)

Bar graph showing variation of mcs value accoring to gender and educational backgrounds

```
plotdata = pd.DataFrame({

    "Male":[25,25,28,26],

    "Female":[25,25,23,21]},

    index=["Intermediate", "Graduation","Post Graduation","Research"])
#y=[1,2,3,4,5,6,7,8,9,10,11,12]
y=[2,4,6,8,10,12,14,16,18,20,22,24,26,28,30]
plotdata.plot(kind="bar",figsize=(15, 10))

plt.title("Mcs Value (Score < 60) w.r.t Gender and Education")
plt.xlabel("Education")
max_ylim = max(y) + 3
min_ylim = min(y) -1
plt.ylim(min_ylim, max_ylim)
plt.ylabel("Number of people")
plt.grid(b = True, color ='grey',
        linestyle ='-.', linewidth = 0.5,
        alpha = 1)

plt.savefig("mcsvalue_Education.jpg")
```