

## Student Project Ethics Approval Form

### KF7029 MSc Computer Science and Digital Technologies Project

You should use this document if your project is not high risk. Please complete this document and discuss your study with your supervisor before you collect any data. *Failure to complete this document and have all aspects signed off and approved by your supervisor risks a notable deduction in your grade and may risk a case of Academic misconduct.*

Please ensure that your project meets the conditions of the existing module level ethics application (available on Blackboard). If it does not, then you will need to submit a full ethics application instead via the main university ethics system.

*Please note that this is a word version but the module ethics approval process will use the assignment submission system in Blackboard to record the student submission and the supervisor/second marker (where appropriate) sign off.*

Student Name:	Sarthak Tyagi
Student ID:	21025925
Programme Name (e.g. MSc Computer Science, BSc Data Science):	MSc Data Science
Project Title:	Artificial intelligence model to minimize adverse effect of flatfoot on Lower back pain.
Supervisor Name:	Mr. Kamlesh Mistry
Second Supervisor:	Dr. Zeyneb Kurt
What type of study are you using (check all that apply):	<input type="checkbox"/> Questionnaire or Survey <input type="checkbox"/> User Studies <input type="checkbox"/> Data Generated by Systems <input checked="" type="checkbox"/> Secondary Data Analysis <input type="checkbox"/> No data collected from humans

Please answer the following questions and complete all information in full:

**1. Human Participants:** does your study involve human participants **YES/NO**

If **YES**, please answer the following questions and ensure that you include your participant information sheet, participant consent sheet and any participant recruitment materials/permission letters for participants in Appendix B:

1a) Who are your participants and what is the inclusion criteria you will be using?	I will be considering participant who have flat feet.
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1b) How many participants will you recruit and from where?	It will be around 3-4.
1c) Are there any exclusion criteria (reasons why people should not participate)?	Not Applicable

- 2. Data Collection:** Will your study collect any primary data or use any secondary data not in the public domain? **YES/NO**

Please complete the following questions, noting that somebody should be able to read this and replicate your approach:

2a) What type of data are you going to use? (Identify main types of information/data)	I will be using the result data of participants that consists of measurement of their ankles and knees.
2b) What procedures will you use to collect data (include all equipment/methods you plan to use)	The data will be recorded in the real time using a camera based artificial intelligence system.
2c) What methods will you use to analyse this data?	Statistical measures will be used to analyse this data.

### 3. Data Management

Standard phrases have been added to the information sheet (available on Blackboard). In rare instances, these may not be appropriate for your study. If not, please describe any additional data management procedures below:

Data management will be done according to the university guidelines. Only numerical data will be recorded of the participants.

### 4. Risk Assessment, Health and Safety

All research activity carried out by Northumbria University is subject to risk assessment and health and safety issues. Depending on the nature of your research work, you may need to use one of the risk assessments below and/or complete a Project Risk Assessment in discussion with your supervisor. Once you have identified risks and associated health and safety issues, you may need to consult relevant technical and other staff for further advice and guidance. Further information including a blank risk assessment form for research can be found here: [Risk Assessment \(northumbria.ac.uk\)](http://northumbria.ac.uk/RiskAssessment).

Please check this box after you have read and understood [ethics](#) and [health and safety](#) information

☒ I confirm I have read the University's health and safety policy and ethics policy. I have read and understood the requirement for the mandatory completion of risk assessments and that my study does not deviate from the module level approval ethics information on Blackboard: *Relevant risk assessments are listed in the ethics application. If your project needs additional risk assessments, then you will need to submit a new ethics application. Please identify the elements of the listed risk assessment that are relevant for your study and the risk assessment(s) you are working with. Note that these are only relevant if you are collecting data face-to-face.*

Please check the relevant boxes:

- ☒ No physical risks
- ☐ HL\_RISK\_173 Testing in an external environment
- ☐ HL\_RISK\_722 Face-to-face interview
- ☐ HL\_RISK\_727 Group interview

Your Supervisor and Second Supervisor (where appropriate) will approve this ethical submission using the following checklist. Please check the Blackboard ethics submission area for the module **BEFORE** starting your practical research to make sure you have ethical approval in place. It is your responsibility to complete this ethics application and check it has been approved before starting your main research project.

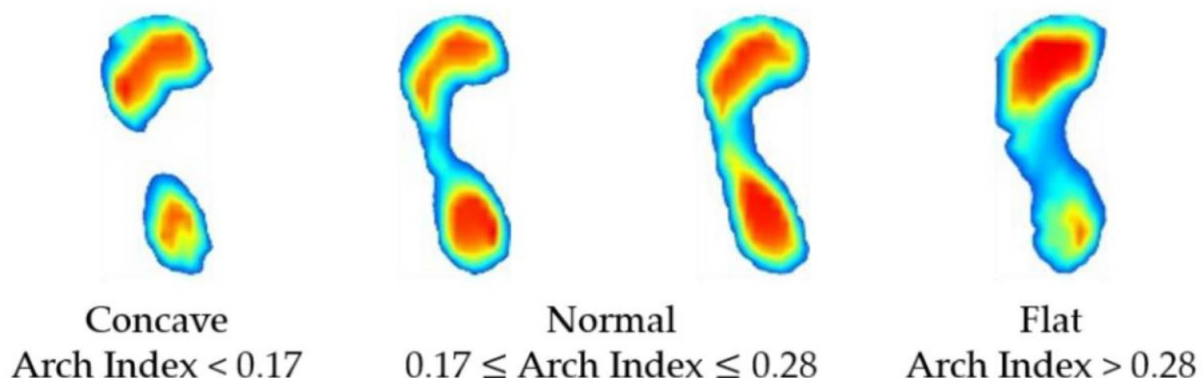
- ✓ Ethics Form Complete
- ✓ Ethical Concerns Acknowledged
- ✓ Research Tools Checked
- ✓ All relevant forms included (consent, etc)
- ✓ Ethics is not high risk

## Appendix A: Proposal Outline

You must include an outline of your main proposal here that you are seeking ethical approval for. This would normally be the research proposal you developed in KF7028 Research Methods and Project Management, but please make sure you have updated it to reflect your latest thinking and plans. If you do not have a proposal already in place, please complete this section to include a minimum of the following elements:

### Introduction:

People with flat feet are more likely to experience lower back problems than the average person these days. Due to having flatfoot, a person's inside feet press flat against the ground with no arch with the floor. This causes the ankle and shin bone to turn inwards while standing and walking. Not only does the inclination cause stress on the ankles and hips, but it also changes the alignment of the hip and knee joints, which can result in a variety of lower back problems. (MASS4D® Foot Orthotics ,no date). This problem has an adverse effect on work quality and can make it challenging to do daily tasks that require physical activity(Pita-Fernandez, S. *et al.* ,2017). According to a face-to-face survey of 1798 people conducted by (Almutairi, A.F. et al., 2021). It was shown that 65.9% of the individuals had lower back pain of some form. Additionally, it was found that having flat feet is more likely to be linked to both acute and chronic lower back discomfort.



Prior studies mostly focused on the severity of flat feet and wearable technology that may identify them. According to one study (Kim, J.-Y. et al. , 2020), wearable devices that track a person's incorrect walking pattern by identifying when they have a foot deformation using sensors are being developed. Three sensors—two force sensors, one flexible sensor, and one—are utilized to automatically gather information about the walking movement. This information is then sent to a computer for additional deep learning calculations. This aids in the early discovery of flat feet so that a person can receive prompt medical care.

A classification model was created utilizing data from plantar pressure measurement devices in other studies, such as (Chae, J, et al. , 2020). The numerical and picture data are then fed into several models, including VG16, KNN, InceptionV3, etc. A stacking ensemble is used to combine two heterogeneous data in order to increase the model's robustness and accuracy. Because it performs better than other models in this study, the stacking ensemble was made up of VG16 and KNN. The 96 participants that collectively make up the pressured data for this study constitute a quite small quantity, and the model achieves accuracy with a f1 score of 92.55%.

The healthcare professionals' analysis and development of goods are made easier by this classification of foot deformity. It overcomes the shortcomings of past research, which did not provide any models for numerical categorization. As a result, experts found it difficult to design and study products related to feet.

## **Rationale for your Research**

Previous research (Kim, J.-Y. et al. ,2020) assists medical practitioners in early pain detection and treatment by assisting in a better evaluation and analysis of the impact of flatfoot on lower back pain. On the other hand (Chae, J., et al. ,2020) Given a mathematical technique using artificial intelligence, which serves as the basis to develop flatfoot-specific footwear. Medical professionals and equipment that are out of the reach of the public are still required for this research. If so, it still requires a specialist or professional to operate them. This research uses the results and knowledge from earlier studies to create an artificial intelligence model that will assist a person in selecting the appropriate footwear for their body type and help them minimize the adverse effects of having a flatfoot. This will be accomplished through integrating artificial intelligence into peoples' smartphones through an application or website that is user-friendly and open to everyone.

It would provide medical benefits that are accessible to and inexpensive for regular people and help spread knowledge of how crucial wearing the proper footwear is. In 2023, more than 3 million patients will have to wait more than 18 weeks to receive treatment, according to (TheBMA (no date) *NHS backlog data analysis*) statistics. 362,500 people have been waiting for the necessary healthcare for more than a year. Our study will fill the gap between patients waiting for required healthcare treatment and doctors.

## **Research Aim, Scope and Impact**

The purpose of this study is to develop an artificial intelligence system that people with flat feet may use on their smartphones to help them choose shoes that are right for their foot structure and reduce the negative effects on their joints and lower back.

The biggest problem with prior studies is that it is out of the ordinary person's access. You require expert supervision to use the tools associated with the methods used in the previous studies. The goal of this research is to integrate an artificial model into smartphones that are reliable and user-friendly in order to avoid this scenario. They will be given assistance in choosing the proper footwear that will reduce bad posture and the additional stress it places on the joints. It would be simple for anyone to access through their smartphones from any location and would be reliable, durable, and user-friendly.

Precision and dependability ought to come first throughout the entire development process. The impact of this study goes beyond just improving personal health; it also helps boost productivity and raise the standard of work at the workplace. The effects are also going to improve the awareness of individuals of their footwear preferences and how they relate to productivity and health. By removing unnecessary stresses and strains on joints, it will also be beneficial in lowering healthcare costs of individuals. As it will offer an alternate route to people who are waiting for the necessary treatment, the workload on the healthcare providers may decrease.

If this is a success, it will open the door for new developments in the healthcare and footwear industries as well. It will also let individuals appreciate how much a good pair of shoes can do to enhance their quality of life.

## SMART Objectives

The objective of this project is to create an AI system which will use a camera to scan a person's knees, and depending on how inclined their feet are as a result of having flat feet, the system will help them choose the best pair of shoes. It can be included into smartphones via an app or website. They will feel relief since the excessive strain on their lower back joint and other portions will be reduced. The inclination measurement used in this study will also reveal the degree of foot deformity severity for future medical support.

The following goals have been set in place to help the study reach its intended conclusion.

1. Even though this is a unique study, the available and recent research on the same subjects—flatfoot detection and foot deformities—will be critically reviewed and analyzed. This will be done to better comprehend the subject and assess competing theories in search of fresh insights and solutions to related problems. To create a more comprehensive model, medical considerations will also be taken into account.  
**Outcome** : Build a research foundation by identifying research gaps and comprehending the background of the topic. By taking into account prior research, the quality of the current study will also be improved.
2. Gather the necessary training data first, which should include images of both normal and flat-footed people's knees. Case studies and literature reviews can be used to accomplish this, and they will be useful in determining whether the data are relevant for this research.  
**Outcome** : The desired result was accurate data appropriate to the study.
3. Start building the model using transfer learning or, if required, a special model. To help the model capture more complex aspects, various data pre-processing will be done. Hyperparameter adjustments will be made to address overfitting, bias, and to increase accuracy in order to make additional improvements.  
**Outcome** : Based on the knee data that will be given to the model, predictions will be made.
4. Untrained photos will subsequently be used to test the model that was built to determine its accuracy. Additionally, the model will be tested on a group of participants, and as a result of their feedback, it will be improved.  
**Outcome** : It will make it easier to determine whether or not the model complies with the standards and specifications.
5. Following the testing phase, the results will be analyzed and interpreted to gain knowledge about the model and be put to use in order to fix any flaws. Additionally, it will make it clear whether the research's goal has been met or not.  
**Outcome** : will learn more about the model's performance and effectiveness.
6. A final report on the study will be produced, along with suggestions for more research. It comprises in-depth observations made throughout the model's construction, as well as insights, analyses, interpretations, and limits.  
**Outcome** : an overview of the research methodologies, findings, and implications, as well as a list of potential future improvement areas.

## Research Approach:

We will be utilising a posture estimation model to get over the shortcomings of the prior research, which required professional equipment and assistance to assess whether a person had flat feet or not, and to make it simply accessible to the user through their smartphones. Models for estimating posture are fast and reliable. They can quickly and accurately estimate the human's key points while yet keeping a decent frame rate.

We use posture estimation models to find the critical human body parts, and OpenCV will deliver the estimation results in real time. Then, using OpenCV, MoveNet's key spots will be marked on the human body in real time. Additionally, we will draw on the knowledge gained from the literature to predict flatfeet. Since flat feet lead the ankle to pronate and the knees to adopt a valgus position, a function connecting the knee and ankle joints will be developed. Euclidean distance will be used to measure the separation between these pairs of joints. The classification of flat feet versus regular feet will subsequently be based on this distance.

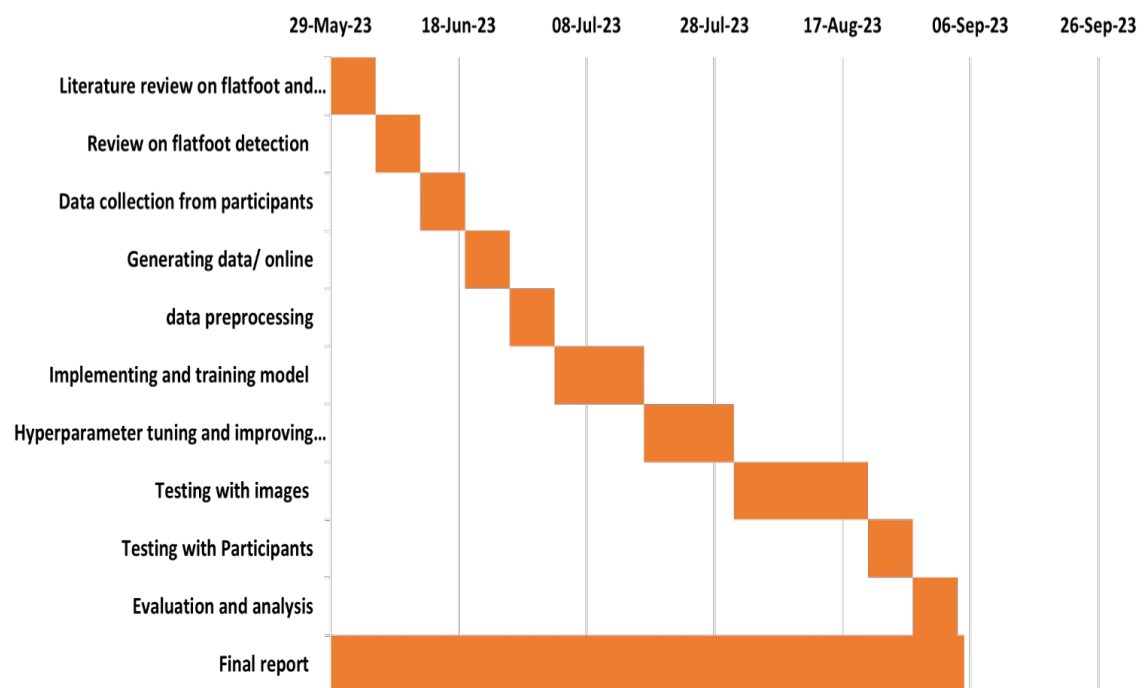
People with flat feet and people with normal feet will be tested using the artificial intelligence model that has been created to evaluate the model. The evaluation's results will then be examined, and important conclusions will be taken from them.

To prevent privacy violations, it will be ensured that the data is safe, accessible, and private throughout the research. Only authorised people will be able to use it. The organised data will be statistically analysed to generate helpful insights, conclusions, and suggestions based on patterns and trends.

## Project Plan

Objective	Deliverable	Start-End Date	
<b>Objective 1.</b> Even though this is a unique study, the available and recent research on the same subjects flatfoot detection and foot deformities will be critically reviewed and analyzed..... Subtask 1: Research on the impact of flatfeet on the human body and deformity/flatfoot detection Subtask 2 : Research on flatfoot footwear	Foundation draft will be made that includes research gaps, background and findings from previous research.	Week 1 - Week 2	One week per task
<b>Objective 2.</b> Data collection	Data that is appropriate for the research will be gathered.	Week 3-Week4	2 Weeks

<b>Objective 3.</b> Implementing the prediction Model. Subtask 1. Data preprocessing and augmentation Subtask 2. Creating the classification model Subtask 3. Hyperparameter tuning	Implemented prediction model.	Week 5-Week 8	Week 1 : Subtask 1 Week 1 And Week 2 : Subtask 2 Week 3.
<b>Objective 4.</b> Testing with images and the participants. Subtask 1. Testing with untrained images. Subtask 2. Testing the model with the participants.	Effectiveness and performance of the prediction mode.	Week 9 - Week 10	
<b>Objective 5.</b> Evaluations and analysis.	Results and limitations.	Week 11	
<b>Objective 6.</b> Final Draft	Final submission of the report.	Week 12	





## Ethics, Risk and Related Issues

**Ethics:** The participation of the participants and users who will use the research is the fundamental ethical consideration. Before they participate in the study, participants and users should give their informed consent. The research should be completely transparent and accountable, and all participants should be informed of its goals, advantages, and aims. Before the customer participates, they will be provided with a thorough explanation of how their data will be stored, processed, and evaluated (*Right to be informed*, 2020). Before they give their consent, all of their questions should be answered. To safeguard the privacy of the individuals, all the data gathered must be kept secret. People should have the freedom to choose not to participate in research at any time, in which case all of their data will be completely erased.

**Risk :** Cyberattacks and data breaches are risk factors that are considered in this study. The privacy of the people's personal information might be compromised as a result. Data collection for this study will be challenging because it will involve people's knees images, which most people find uncomfortable to share. In order to avoid this situation, data may need to be obtained from the connections of the researchers, from the internet, or, if necessary, generated intentionally. If still there's a requirement of data to be collected from people then it will be done by following (*Privacy impact assessment*, 2021). This will reduce the danger to the participants' privacy. In the research, psychological risk factors like nervousness and anxiety should be minimized. The possibility of bias could also be a problem, so it is important to avoid it by using distinct data and people.

**Legal:** Since this study utilizes knee pictures, privacy issues may be raised. Legal considerations in accordance with include the need to obtain participants' consent before collecting any data to ensure compliance with data privacy laws and regulations (*Recital 159 - processing for scientific research purposes*, 2019). An appropriate disclaimer should be included to minimize liability if the model created is utilized for medical treatments. Patents that are related to intellectual property rights should be defined and safeguarded.

**Social:** The model that was used in this study may have been biased towards some groups of people and discriminatory toward those who have foot abnormalities. To reduce the model's biases, significant steps should be done. Given its high cost, healthcare can be difficult for some people to access and afford, so barriers to access should be removed.

**Security:** Data privacy and the artificial intelligence model may be impacted by cyberattacks on the systems and model. It is important to consider appropriate security measures that will shield sensitive user data from cyberattacks as well as from being used for malicious purposes. To limit illegal access, the data should be password- and encryption-protected (*Encryption*, 2021).

**Sustainability:** Training a huge number of photos requires a lot of processing power, which directly affects the quantity of energy used and the carbon footprint. To get over these issues, code that is minimally computational and optimized should be written. If a cloud provider is chosen to manage and store data, that provider should place a high priority on renewable energy sources.

**Professional:** Professionalism requires treating participants and users with respect and decency. Along with maintaining high standards for the research, total transparency should be ensured throughout the process. This could be accomplished by having expert domain understanding of the medical and artificial intelligence aspects of flatfoot.

## References.

“IS HAVING FLAT FEET REALLY BAD?” (no date) MASS4D®. Available at: <https://mass4d.com/blogs/articles/is-having-flat-feet-really-bad>.

Pita-Fernandez, S. et al. (2017) *Flat foot in a random population and its impact on quality of life and functionality*, *Journal of clinical and diagnostic research : JCDR*. U.S. National Library of Medicine. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5449819/> (Accessed: May 4, 2023).

Almutairi, A.F. et al. (2021) *The prevalence and factors associated with low back pain among people with flat feet*, *International journal of general medicine*. U.S. National Library of Medicine. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8312604/> (Accessed: April 23, 2023).

Kim, J.-Y. et al. (2020) *Flat-feet prediction based on a designed wearable sensing ... - IEEE xplore*. Available at: <https://ieeexplore.ieee.org/document/9239946/> (Accessed: April 23, 2023).

Chae, J., Kang, Y.-J. and Noh, Y. (2020) *A deep-learning approach for foot-type classification using heterogeneous pressure data*, *Sensors (Basel, Switzerland)*. U.S. National Library of Medicine. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7472491/> (Accessed: April 24, 2023).

TheBMA (no date) *NHS backlog data analysis*, *The British Medical Association is the trade union and professional body for doctors in the UK*. Available at: <https://www.bma.org.uk/advice-and-support/nhs-delivery-and-workforce/pressures/nhs-backlog-data-analysis> (Accessed: May 3, 2023).

Active rehab (2022) *Flat feet may be the cause of your chronic lower back pain*, *Flat Feet May be the Cause of Your Chronic Lower Back Pain: Active Rehab Clinics: Sports Injury Specialists*. Available at: <https://www.activerehabchicago.com/blog/flat-feet-may-be-the-cause-of-your-chronic-lower-back-pain> (Accessed: 03 May 2023).

*Privacy impact assessment* (2021) *General Data Protection Regulation (GDPR)*. Available at: <https://gdpr-info.eu/issues/privacy-impact-assessment/> (Accessed: 03 May 2023).

*Right to be informed* (2020) *General Data Protection Regulation (GDPR)*. Available at: <https://gdpr-info.eu/issues/right-to-be-informed/> (Accessed: May 3, 2023).

*Recital 159 - processing for scientific research purposes* (2019) *General Data Protection Regulation (GDPR)*. Available at: <https://gdpr-info.eu/recitals/no-159/> (Accessed: May 3, 2023).

*Encryption* (2021) *General Data Protection Regulation (GDPR)*. Available at: <https://gdpr-info.eu/issues/encryption/> (Accessed: May 3, 2023).

## Appendix B: Participant Information

Note: this section **MUST** be completed if you are including *human participants* in your study

Please include here your participant information sheet, participant consent form plus any participant recruitment materials and permission letters.



**Northumbria  
University**  
NEWCASTLE

**Faculty of Engineering and Environment**

### **Participant Information Sheet**

**Study Title: Flatfeet classification using artificial intelligence.**

**Investigator: Mr Kamlesh Mistry**

You are invited to take part in this research study. Before you decide it is important for you to read this leaflet so you understand why the study is being carried out and what it will involve.

Reading this leaflet, discussing it with others or asking any questions you might have will help you decide whether you would like to take part.

#### What is the purpose of the study?

The purpose of this study is to develop an artificial intelligence system that will help in suggesting the insoles to the person having flat feet by measuring the distance between the knees and ankles using the smartphone or laptop camera.

#### Why have I been invited to take part?

You have been invited to take part as you meet the following criteria:

- You are an adult aged 18+ years,

- You have a flat foot.
- You have normal foot or high arch.

Do I have to take part?

You are under no obligation to take part and you will not experience any loss of benefit or penalty if you choose not to participate.

What will I have to do?

You will be tested on our artificial intelligence system to take measurement of the distance between your knee and ankle joints. It will also measure the slope of the line joining ankle and knee joints. Only numerical measurement as data will be collected from the participants. This entire process usually takes 20-30 minutes.

What are the exclusion criteria (i.e., are there any reasons why I should not take part)?

You should not take part in this study if:

- Not applicable

What are the possible disadvantages/risks in taking part?

There will be no risk associated in participating in the study.

What are the possible benefits of taking part?

The participant will get to know about the adverse effects they faced in day-to-day life due to flatfeet which they might not be aware about. The results obtained from the study will then be utilized to further improve and work on the model to make it more accurate and easily accessible to the users.

Will my taking part be kept confidential and anonymous?

Yes. You will be allocated a unique participant code that will be used to identify any data that you provide. Your name and other personal details will not be associated with your data, for example any signed informed consent forms will be stored separately.

Only the research team will have access to any identifiable information; paper records will be stored in a locked filing cabinet and electronic information will be stored on the secure University network. This will be kept separate from any data and will be treated in accordance with the Data Protection Act.

#### How will my data be stored?

All data will be stored on the University's OneDrive network and where appropriate additionally protected with a password. Any paper data collected will be locked away in a secure folder.

#### What will happen to the results of the study?

The results will be used for an postgraduate project that will be examined as part of a MSc Data Science degree. Occasionally some results might be presented at a conference or published in a journal, but they will always remain anonymous. All information and data gathered during this research will be stored in line with the Data Protection Act and will be destroyed after a maximum of 3 years following the conclusion of the study. During that time the data may be used by members of the research team, only for purposes appropriate to the research question, but at no point will your personal information or data be revealed.

#### Who is organizing and funding the study?

The present research project has received no funding.

#### Who has reviewed the study?

The study and its protocol and its protocol has received full ethical approval from the Department of Computer and Information Sciences ethics committee. If you require confirmation of this, please contact the Departmental Ethics Lead using the details below and stating the full title and principal investigator of the study:

Name of relevant Department Ethics Lead: Dr. James Nicholson

Department: Computer and Information Sciences

Address: Ellison B113

Phone: 0191 227 4959

Email: [james.nicholson@northumbria.ac.uk](mailto:james.nicholson@northumbria.ac.uk)

### How can I withdraw from the project?

The research you take part in will be most valuable if few people withdraw from it, so please discuss any concerns you might have with the investigators. During the study itself, if you do decide that you do not wish to take any further part then please inform one of the research team as soon as possible, and they will facilitate your withdrawal and discuss with you how you would like your data to be treated in the future. After you have completed the research, you can still withdraw your data by contacting one of the research team (their contact details are provided in the last section of the leaflet), give them your participant number, or if you have lost this, give them your name.

If for any reason, you wish to withdraw your data please contact the investigator within a month of your participation. After this date, it might not be possible to withdraw your individual data as the results might already have been published. As all data are anonymous, your individual data will not be identifiable in any way.

### What happens if there is a problem?

If you are unhappy about anything during or after your participation, you should contact the principal investigator in the first instance. If you feel this is not appropriate, you should contact the Computer and Information Sciences Departmental Ethics Lead via the contact details given above.

#### **Contact for further information:**

**Researcher email:** sarthak.tyagi@northumbria.ac.uk

**Supervisor email:** k.mistry@northumbria.ac.uk

**Faculty of Engineering and Environment**

**INFORMED CONSENT FORM**

Project Title: Artificial intelligence model to minimize adverse effect of flatfoot on Lower back pain

Principal Investigator:

*please tick or initial  
where applicable*

I have carefully read and understood the Participant Information Sheet.

☐

I have had an opportunity to ask questions and discuss this study and I have received satisfactory answers.

☐

I understand I am free to withdraw from the study at any time, without having to give a reason for withdrawing, and without prejudice.

☐

I agree to take part in this study

☐

Signature of participant..... Date.....

(NAME IN BLOCK LETTERS) .....

Signature of researcher: Date.....

(NAME IN BLOCK LETTERS):

