CLAIMS

1. A lower limb loading assessment system comprising:

at least one wearable motion sensor releasably securable to a subject's lower limb that is configured to sense the tibial shockwaves experienced by the lower limb as the subject performs a repetitive physical activity involving repetitive footstrikes of the lower limb with a surface, the wearable motion sensor comprising an accelerometer that is configured to sense acceleration data in at least three orthogonal axes and generate representative multi-axis acceleration data over a time period associated with the physical activity, the wearable motion sensor generating tibial shockwave data comprising the generated multi-axis acceleration data which represents a series of discrete tibial shockwaves from the discrete footstrikes; and

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a data processor that is configured to receive and convert the tibial shockwave data comprising the multi-axis acceleration data sensed by the wearable motion sensor into resultant acceleration magnitude data, and wherein the data processor is configured to process the resultant acceleration magnitude data to generate output feedback data comprising data to assist the subject to minimize future loading in their lower limbs.

2. A lower limb loading assessment system according to claim 1 wherein the data processor is further configured to extract or calculate one or more variables from the received tibial shockwave data or resultant acceleration magnitude data and compare the or each variable to a predetermined threshold or thresholds, and provide feedback data in the form of a real-time alert signal if one or more of the thresholds is exceeded by its associated variable.

3. A lower limb loading assessment system according to claim 2 wherein the data processor is configured to extract peak shock variables representing the peak resultant acceleration magnitude data associated with each discrete footstrike.

4. A lower limb loading assessment system according to claim 3 wherein the data processor is configured to generate a real-time alert signal if any peak shock variables exceed a predetermined threshold.

5. A lower limb loading assessment system according to claim 3 wherein the data processor is configured to calculate an average peak shock variable representing the average of the extracted peak shock variables, and wherein the data processor is configured to generate a real-time alert signal if the average peak shock variable exceeds a predetermined threshold.

6. A lower limb loading assessment system according to claim 2 wherein the data processor is configured to generate footstrike pattern variables representing the footstrike pattern associated with each footstrike as defined by the profile of the resultant acceleration magnitude data for a period associated with each discrete footstrike, and generate a real-time alert signal if any of the footstrike pattern variables exceed a predetermined footstrike pattern threshold.

7. A lower limb loading assessment system according to claim 2 wherein the data processor is configured to generate footstrike pattern variables representing the footstrike pattern associated with each footstrike as defined by the profile of the acceleration data in three axes for a period associated with each discrete footstrike, and generate a real-time alert signal if any of the footstrike pattern variables exceed a predetermined footstrike pattern threshold.

8. A lower limb loading assessment system according to claim 6 or claim 7 wherein data processor is configured to generate the footstrike pattern variables based on tibial shockwave data for each discrete footstrike between heelstrike and toe-off time locations.

9. A lower limb loading assessment system according to any one of claims 2-8 wherein the system further comprises one or more feedback devices mounted to or carried by the user that are triggered by in response to a generated real-time alert signal.

10. A lower limb loading assessment system according to claim 9 wherein the feedback devices comprise any one or more of the following: tactile feedback devices, audible feedback devices, and/or visual feedback devices.

11. A lower limb loading assessment system according to any one of the preceding claims wherein the data processor is configured to process the tibial shockwave data to generate feedback data in the form of data indicative of a session load stimulus.

12. A lower limb loading assessment system according to any one of claims 1-11 wherein the data processor is configured to receive tibial shockwave data from a plurality of activity sessions of the subject from a single day, and generate feedback data in the form of data indicative of a daily load stimulus.

Comment [HB1]: Clarity correction

13. A lower limb loading assessment system according to any one of the preceding claims wherein the data processor is configured to identify the time locations of the heelstrikes associated with each footstrike, and generate feedback data in the form of cadence representing the average time between heelstrikes.

14. A lower limb loading assessment system according to any one of the preceding claims wherein the data processor is configured to:

receive tibial shockwave data from a plurality of separate activity sessions,

convert the 3-axes acceleration data of the tibial shockwave data into resultant acceleration magnitude data,

extract peak shock values representing the peak resultant acceleration magnitude associated with each discrete footstrike of the tibial shockwave data of each of the separate activity sessions,

calculate the average peak resultant acceleration magnitude for each of the separate activity sessions based on the extracted peak shock values, and

generate feedback data representing the calculated average peak resultant acceleration magnitude for each separate activity session.

15. A lower limb loading assessment system according to claim 14 wherein the subject is wearing a different type of footwear in each separate activity session, and the data processor is configured to receive or associate unique identification data relating to each different type of footwear used by the subject with the respective tibial shockwave data of each activity session, and the feedback data generated comprises data representing the calculated average peak resultant acceleration magnitude of each

separate activity session linked with the unique identification data relating to the footwear used in the activity session.

16. A lower limb loading assessment system according to claim 14 or claim 15 wherein the data processor is further configured to compare the calculated average peak resultant acceleration magnitude associated with each activity session and generate further feedback data identifying the activity session having the lowest peak resultant acceleration magnitude.

17. A lower limb loading assessment system according to any one of the preceding claims wherein the accelerometer is a 3-axis accelerometer.

18. A lower limb loading assessment system according to any one of the preceding claims wherein the data processor is communicatively coupled to the wearable motion sensor over a data link.

19. A lower limb loading assessment system according to any one of the preceding claims wherein the data processor is onboard the wearable motion sensor.

20. A lower limb loading assessment system according to any one of the preceding claims wherein the wearable motion sensor is releasably secured to the subject's lower limb between the femoral epicondyle and medial malleolus.

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21. A lower limb loading assessment system according to any one of the preceding claims wherein the wearable motion sensor is releasably secured to the subject's lower limb in the region of the lower $1/3^{rd}$ of the tibia.

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22. A lower limb loading assessment system according to any one of the preceding claims wherein the wearable motion sensor is releasably secured to the subject's lower limb in the region of the medial part of the tibia.

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23. A lower limb loading assessment system according to claim 22 wherein the wearable motion sensor is releasably secured to the subject's lower limb in the region adjacent and above the medial malleolus of the tibia.

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24. A lower limb loading assessment system according to any one of claims 1-21 wherein the wearable motion sensor is releasably secured to the subject's lower limb in the region adjacent and above the lateral malleolus of the tibia.

25. A method of assessing the loading on a subject's lower limb as the subject performs a repetitive physical activity involving repetitive footstrikes of the lower limb with a surface, the method implemented on a computing device and comprising:

receiving tibial shockwave data comprising sensed multi-axis acceleration data from at least one wearable motion sensor releasably secured to the subject's lower limb that comprises an accelerometer that is configured to sense and generate multi-axis acceleration data in at least three orthogonal axes, the sensed multi-axis acceleration data representing a series of discrete tibial shockwaves from the discrete footstrikes;

converting the tibial shockwave data comprising the multi-axis acceleration data into resultant acceleration magnitude data; and

processing the resultant acceleration magnitude data to generate output feedback data comprising data to assist the subject to minimize future loading in their lower limbs.

26. A method according to claim 25 further comprising extracting or calculating one or more variables from the received tibial shockwave data or resultant acceleration magnitude data, comparing the or each variable to a predetermined threshold or thresholds, and generating feedback data in the form of a real-time alert signal if one or more of the thresholds is exceeded by its associated variable.

27. A method according to claim 26 further comprising extracting peak shock variables representing the peak resultant acceleration magnitude data associated with each discrete footstrike.

28. A method according to claim 27 further comprising generating a real-time alert signal is any peak shock variables exceed a predetermined threshold.

29. A method according to claim 27 further comprising calculating an average peak shock variable representing the average of the extracted peak shock variables, and

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generating a real-time alert signal if the average peak shock variable exceeds a predetermined threshold.

30. A method according to claim 26 further comprising generating footstrike pattern variables representing the footstrike pattern associated with each footstrike as defined by the profile of the resultant acceleration magnitude data for a period associated with each discrete footstrike, and generating a real-time alert signal if any of the footstrike pattern variables exceed a predetermined footstrike pattern threshold.

31. A method according to claim 26 further comprising generating footstrike pattern variables representing the footstrike pattern associated with each footstrike as defined by the profile of the acceleration data in three axes for a period associated with each discrete footstrike, and generating a real-time alert signal if any of the footstrike pattern variables exceed a predetermined footstrike pattern threshold.

32. A method according to claim 30 or claim 31 comprising generating the footstrike pattern variables based on tibial shockwave data for each discrete footstrike between heelstrike and toe-off time locations.

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33. A method according to any one of claims 26-32 comprising triggering one or more feedback devices mounted to or carried by the user in response to a generated real-time alert signal.

34. A method according to claim 33 wherein the feedback devices comprise any one or more of the following: tactile feedback devices, audible feedback devices, and/or visual feedback devices.

35. A method according to any one of claims 25-34 comprising processing the tibial shockwave data to generate feedback data in the form of data indicative of a session load stimulus.

36. A method according to any one of claims 25-34 comprising receiving tibial shockwave data from a plurality of activity sessions of the subject from a single day, and generating feedback data in the form data indicative of a daily load stimulus.

37. A method according to any one claims 25-36 comprising identifying the time locations of the heelstrikes associated with each footstrike, and generating feedback data in the form of cadence representing the average time between heelstrikes.

38. A method according to any one of claims 25-37 comprising:

receiving the tibial shockwave data from a plurality of separate activity sessions,

converting the 3-axes acceleration data of the tibial shockwave data into resultant acceleration magnitude data,

extracting peak shock values representing the peak resultant acceleration magnitude associated with each discrete footstrike of the tibial shockwave data of each of the separate activity sessions,

calculating the average peak resultant acceleration magnitude for each of the separate activity sessions based on the extracted peak shock values, and

generating feedback data representing the calculated average peak resultant acceleration magnitude for each separate activity session.

39. A method according to claim 38 wherein the subject is wearing a different type of footwear in each separate activity session, and the data processor is configured to receive or associate unique identification data relating to each different type of footwear used by the subject with the respective tibial shockwave data of each activity session, and the feedback data generated comprises data representing the calculated average peak resultant acceleration magnitude of each separate activity session linked with the unique identification data relating to the footwear used in the activity session.

40. A method according to claim 38 or claim 39 further comprising comparing the calculated average peak resultant acceleration magnitude associated with each activity session and generating further feedback data identifying the activity session having the lowest peak resultant acceleration magnitude.

41. A method according to any one of claims 25-40 wherein the accelerometer is a 3-axis accelerometer.

42. A method according to any one of the preceding claims wherein the wearable motion sensor is releasably secured to the subject's lower limb between the femoral epicondyle and medial malleolus.

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43. A method according to any one of the preceding claims wherein the wearable motion sensor is releasably secured to the subject's lower limb in the region of the lower 1/3rd of the tibia.

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44. A method according to any one of the preceding claims wherein the wearable motion sensor is releasably secured to the subject's lower limb in the region of the medial part of the tibia.

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45. A method according to claim 44 wherein the wearable motion sensor is releasably secured to the subject's lower limb in the region adjacent and above the medial malleolus of the tibia.

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46. A method according to any one of claims 25-43 wherein the wearable motion sensor is releasably secured to the subject's lower limb in the region adjacent and above the lateral malleolus of the tibia.

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