CLAIMS

What is claimed is:

1. A system comprising:

a hip joint comprising:

a rotation axis;

a first member rotatable about the rotation axis and having a lower body connection location configured to be coupled to a lower body link;

a second member rotatable about the rotation axis and having an upper body connection location configured to be coupled to an upper body link; and

an adjustable force mechanism coupled to at least one member of the first member and the second member and configured to apply an adjustable force to the at least one member to hinder rotation of the upper body connection location with respect to the lower body connection location in a rotational direction, the adjustable force mechanism comprising an actuator housed within and fixed with respect to one body link of the lower body link and the upper body link.

2. The system of claim 1, further comprising:

the lower body link; and

the upper body link.

3. The system of claim 2, wherein the lower body connection location and the lower body link are integrated with each other.

4. The system of claim 3, wherein the upper body connection location and the upper body link are integrated with each other.

5. The system of claim 4, wherein the upper body link is configured to at least partially enclose hips of a user, the upper body link configured to be, in operation,

in a substantially horizontal plane, and the lower body link configured to be, in operation, in a substantially vertical plane.

6. The system of claim 1, wherein the hip joint has a preloaded mode and a non-preloaded mode, and wherein in the non-preloaded mode the upper body connection location is at about a 90 degree orientation with respect to the lower body connection location.

7. The system of claim 1, wherein the adjustable force mechanism comprises:

a torsion spring comprising:

a first spring leg rotationally coupled to the first member;

a second spring leg rotationally coupled to the second member; and

a spring rotation axis that is collinear with the rotation axis; and

a rotatable ratchet mechanism coupled between the first spring leg and the first member, the rotatable ratchet mechanism configured to, when rotated, rotate the torsion spring and apply a variable preload to the torsion spring.

8. The system of claim 7, the rotatable ratchet mechanism further comprising a ratchet drum that forms a drum interior void configured to receive the first spring leg, a stop positioned in the drum interior void configured to limit rotation of the first spring leg, the ratchet drum further comprising a first planar face and a plurality of angled ratchet teeth annularly disposed about the first planar face;

the first member further comprising a second planar face and a plurality of angled pawl teeth annularly disposed about the second planar face; and

the angled ratchet teeth and the angled pawl teeth configured to allow rotation in a first rotational direction of the angled ratchet teeth with respect to the angled pawl teeth when in contact with one another, and to prohibit rotation in a second rotational direction of the angled ratchet teeth with respect to the angled pawl teeth when in contact with one another.

9. The system of claim 8, wherein the adjustable force mechanism further comprises a cup coupled between the torsion spring and the second member, the cup forming a cup interior void configured to receive the second spring leg, a stop positioned in the cup interior void configured to limit rotation of the second spring leg, the cup further comprising a third planar face and a plurality of extensions extending therefrom; and

the second member further comprising a fourth planar face and a plurality of openings configured to receive the plurality of extensions to prevent rotation of the cup with respect to the second member.

10. The system of claim 1, wherein the adjustable force mechanism comprises:

a rod hingedly coupled to one member of the first member and the second member;

an extension spring coupled to the rod;

a disk coupled to the extension spring and housed in one link of the lower body link and the upper body link, the disk forming a threaded opening;

a threaded rod threadably engaged with the threaded opening; and

a user-adjustable rotation mechanism configured to rotate the threaded rod to slide the disk with respect to the one link and thereby apply tension to the extension spring.

11. The system of claim 10, wherein the user-adjustable rotation mechanism comprises a ratchet and pawl mechanism.

12. The system of claim 11, wherein the user-adjustable rotation mechanism comprises a user-selectable quick release mechanism which, when activated, allows the extension spring to return to a non-tensioned state.

13. The system of claim 10, wherein the one member comprises the first member and the one link comprises the upper body link.

14. The system of claim 10, wherein the one member comprises the second member and the one link comprises the lower body link.

15. The system of claim 1, wherein the adjustable force mechanism comprises:

a rod hingedly coupled to one member of the first member and the second member;

an extension spring coupled to the rod; and

wherein the actuator comprises a motor and an actuator arm, the motor configured to selectively extend or retract the actuator arm, the actuator arm being coupled to the extension spring.

16. The system of claim 1, wherein the adjustable force mechanism comprises:

a rod hingedly coupled to one member of the first member and the second member; and

wherein the actuator comprises a motor and an actuator arm, the motor configured to selectively extend or retract the actuator arm, and the actuator arm hingedly coupled to the rod.

17. The system of claim 16, wherein the adjustable force mechanism further comprises:

a user-selectable switch coupled to the actuator.

18. A system comprising:

a hip joint comprising:

a rotation axis;

a lower body link rotatable about the rotation axis, the lower body link having a lower body link hip joint end and a lower body link distal end;

an upper body link rotatable about the rotation axis, the upper body link having an upper body link hip joint end; and

an adjustable force mechanism coupled to at least one hip joint end of the lower body link hip joint end and the upper body link hip joint end and configured

to apply an adjustable force to the at least one hip joint end to hinder rotation of the upper body link with respect to the lower body link in a rotational direction.

19. The system of claim 18, wherein:

the adjustable force mechanism comprising an actuator housed within and fixed with respect to one body link of the lower body link and the upper body link; and

the upper body link comprises a second upper body link hip joint end and is configured to at least partially enclose hips of a user, the upper body link configured to be, in operation, in a substantially horizontal plane, and the lower body link configured to be, in operation, in a substantially vertical plane.

20. The system of claim 19 wherein the adjustable force mechanism further comprises:

a rod hingedly coupled to one body link of the lower body link and the upper body link;

an extension spring coupled to the rod; and

wherein the actuator comprises a motor and an actuator arm, the motor configured to selectively extend or retract the actuator arm, the actuator arm being coupled to the extension spring.

21. An exoskeleton comprising:

an upper body exoskeleton comprising an upper body link;

a lower body exoskeleton comprising a lower body link; and

a hip joint that couples the upper body exoskeleton to the lower body exoskeleton, the hip joint comprising an adjustable force mechanism coupled to at least one body link of the upper body link and the lower body link and configured to apply an adjustable force to the at least one body link to hinder rotation of the upper body exoskeleton with respect to the lower body exoskeleton in a rotational direction, the adjustable force mechanism comprising an actuator housed within and fixed with respect to one body link of the lower body link and the upper body link.

22. The exoskeleton of claim 21 wherein the hip joint further comprises a tool connection structure configured to couple to a tool assembly that is positioned in front of a user, wherein the upper body link is configured to encircle a back of the user.

23. The exoskeleton of claim 21 wherein the adjustable force mechanism further comprises:

a rod hingedly coupled to one body link of the lower body link and the upper body link;

an extension spring coupled to the rod; and

wherein the actuator comprises a motor and an actuator arm, the motor configured to selectively extend or retract the actuator arm, the actuator arm being coupled to the extension spring.