Table 1. Study overview

Reference	Population	Muscles Stimulated	E-STIM Protocol
Abitante [24]	10 healthy adults (6M, 4F); age: 23.8 years	Quadrcieps, hamstrings, tibialis anterior, and gastrocnemius	Frequency = 50Hz, width = 400μs. Performed 1s contractions with either 3s (75 reps), 4s (60 reps), or 5s (50 reps) rest periods. Amplitude was set to maximal tolerable comfort level. Each protocol lasted 5 minutes.
Ashley [25]	11 individuals with spinal cord injuries (10M, 1F); age: 32.1 years, 5 individuals without spinal cord injuries (3M, 2F); age: 21.5 years	Quadriceps	Square monophasic waves. Frequency = 50Hz, width = 250μs. 4 second contraction with 4 second rest. Amplitude set to reach full knee extension. 20 minute protocol.
Banerjee [17]	10 healthy adults (8M, 2F); age: 37.6 years	Quadriceps, hamstrings, and gluteal muscles	Frequency = 4Hz. Amplitude went up to 40% of maximal stimulator output (120 mA).12 minute protocol.
Chen [26]	9 healthy male adults; age: 28 years	Quadriceps and plantar flexors	Biphasic pulses. Frequency = 20 Hz, 1s on 1s off. Amplitude was set to maximal tolerable intensity without feeling discomfort. 2 hour protocol.
Fornusek [28]	9 males with spinal cord injuries; age: 48 years	Quadriceps, hamstrings, and gluteal muscles	Biphasic rectangular pulses. Frequency = 35 Hz, width = 300 μs. Amplitude was increased from 40 to 140 mA over 10 min, and then held constant at 140 mA for the next 25 min. 15 minute protocol.
Grosset [30]	9 obese adults (3M, 6F); age = 43.8 years	Quadriceps and hamstrings	Biphasic symmetrical pulses. Frequency = 5 Hz, width = 760 – 857 μs, Amplitude was increased to maximal tolerable intensity. 1 hour protocol.
Galvan [29]	10 overweight or obese Hispanic adults (2M, 8F); age: 36.8 years	Quadriceps	Biphasic pulses. Frequency = 50 Hz, width = 300 μs, Amplitude set to maximal tolerable intensity. 30 minute protocol.
Hamada [32]	6 healthy males; age: 24 years	Quadriceps	Biphasic pulses. Frequency = 20 Hz, width = 200 μs. Amplitude set to 80 volts for non-painful stimulation. 1 second on-off duty cycle. 20 min protocol.
Hamada [31]	8 healthy males; age: 24.8 years	Tibialis anterior, plantar flexors, quadriceps, hamstrings	Biphasic pulses. Frequency = 20 Hz, width = 200 μs. Amplitude set to 80 volts for non-painful stimulation. 1 second on-off duty cycle. 20 min protocol.
Hirata [33]	10 healthy males; age: 27 years	Quadriceps	Frequency = 20Hz, width = 200 μs. 1 second on-off duty cycle. Stimulation voltage started at 20 volts and progressively increased intil the maximum tolerable level.
Hsu [13]	40 healthy adults (18M, 22F); age: 28.2 years	Quadriceps, hamstrings, gluteal maximum, abdominal muscles	Biphasic square pulses. Frequency = 20 Hz. Duty cycle on/off = 1:2. 10 min sensory level (subject felt NMES), 10 min motor threshold (visible contractions), and 10 min maximal intensity comfortably tolerated.
Isakov [14]	3 individuals with spinal cord injuries; age: 36.3 years	Quadriceps and gluteus muscles	Frequency = 24Hz, width = 300 μs, amplitude = 120 volts. 10-30 minute protocol.

Janssen [19]	12 healthy males; age: 25.1 years	Quadriceps, hamstrings, plantar flexors, and tibialis anterior	Individuals completed each of the following: left leg at 35Hz, right leg at 35 Hz, both legs at 35 Hz, both legs at 3 Hz, both legs at 1Hz. All protocols involved rectangular pulses with a width of 300 μs. Amplitude was set at the maximum tolerable. Duty cycle on/off 6:20. 5 minute protocols.
Lago [35]	16 early phase septic shock patients (12 M, 4F); age: 56 years. 21 late phase septic shock patients (11M, 10F); age: 57 years	Plantar flexors	Biphasic symmetrical pulses. Frequency = 50Hz, width = 250 μs. Duty cycle on/off = 2:5. Amplitude was increased to generate a visible muscle contraction. 30 minute protocol.
Laskin [36]	8 individuals (7M, 1F) with spinal cord injuries; age: 27.9 years	Quadriceps and hamstrings	40 minute protocol.
Ma [23]	9 males with spinal cord injuries; age: 50 years	Quadrcieps, hamstrings, gluteals, plantar flexors.	Biphasic square pulses. Frequency = 75Hz, width = 500 μs. Amplitude was set to induce visible muscle contractions at comfortable levels. Four different protocols. Two involved all 4 muscle groups, while two only involved the gluteals and hamstrings. Duty cycles on:off were either 1:4 or 1:8. Each protocol was 10 minutes.
Matsushima [37]	13 healthy males; age: 28 years	Quadriceps, hamstrings, gluteus maximus, and plantar flexors.	Frequency = 4 Hz, width = 250 μs. Amplitude was increased to achieve a VO_2 of 14 ml/kg/min. 20 minute protocols.
Minogue [39]	11 healthy males; age: 34.2 years	Quadriceps	Biphasic pulses. Frequency = 4 Hz. Amplitude was set at the maximal tolerable. Phase duration of 600 μs with an interphase interval of 100 μs. 30 minute protocol.
Minogue [38]	10 healthy males; age: 35 years	Quadriceps	Biphasic pulses. Phase duration of 600 μs with an interphase interval of 100 μs. Several protocls were completed across different frequencies including 1, 2, 4, 5, 6, 8, 10, and 12 Hz. Amplitude was set at the maximal tolerable. 4 minute protocols.
Miyamoto [42]	13 healthy males; age: 21.7 years	Quadriceps, hamstrings, gluteus maximus, triceps, and plantar flexors.	Frequency = 4 Hz, width = 250 μs. Amplitude was increased until reaching approximately 3 METs. 30 minute protocol.
Perez-De-Arrilucea-Le-Floc'h [20]	10 healthy males; age: 21.6 years	Upper legs, upper arms, upper back, gluteal, abdomen, chest, lower back, and shoulders.	Width ranged from 200-400 μs depending on muscle group. Several protocls were completed across different frequencies including 1, 2, 4, 6, 8, and 10 Hz. Duty cycle was 99% (continued impulse). Amplitude set to maximal tolerable intensity. 6 minute protocol.
Sillen [10]	13 individuals with COPD; age: 65 years	Quadriceps	Biphasic symmetrical pulses. Frequency = 75 Hz, width = 410 μs. Duty cycle on:off = 6:29. Amplitude increased to maximal tolderable. 21 minute protocol.
Sillen [21]	17 individuals with COPD; age: 67 years	Quadriceps	Biphasic symmetrical pulses. Low frequency protocol used a frequency of 15 Hz, width = 390 μs, and duty cycle on:off = 8:2. 29 minute protocol. High frequency protocol used a frequency of 75 Hz, width = 410 μs, and duty cycle on:off = 6:29. 21 minute protocol. Both protocols used an amplitude of maximum tolerable.

Takeda [44]	15 healthy males; age: 23 years	Quadricpes, hamstrings, and gluteal muscles	Biphasic square pulses. Frequency = 4 Hz, width = 100 μs. Amplitude set to maximum tolerable. 3 minute protocol.
Theurel [46]	12 healthy males; age: 25 years	Quadriceps	Biphasic symmetrical pulses. Frequency = 75 Hz, width = 400 μs Duty cycle on:off = 6.25:20. Amplitude set to maximal tolerable. Protocol involved 40 contractions in 17.5 minutes.
Tseh [47]	20 healthy males; age: 35 years	Quadriceps	Frequency ranged from 2-5 Hz. Duty cycle on:off = 3:3. Amplitude set to a comfortably tolerable level.
Valli [15]	13 healthy individuals (7M, 6F); age: 50.6 years	Quadriceps	7 second contraction with frequency between 60 to 90 Hz, 15 second rest with a 20 Hz frequency. Amplitude set to maximal tolerable. 30 minute protocol.
Woelfel [22]	10 individuals with spinal cord injuries (9M, 1F); age: 39 years	Quadriceps and hamstrings	The protocol involved both frequencies of 1 and 3 Hz each completed with amplitudes of 50 and 100 mA. Protocols lasted 6 minutes.
Zinner [48]	11 healthy individuals; age: 24 years	Upper arms, upper and lower back, chest, and stomach	Frequency = 85 Hz, width = 400 μs, duty cycle on:off = 10:2. Amplitude was increased to maximal tolerable. 3 minute protocol.
Pollack [43]	11 individuals with spinal cord injuries (7M, 4F); age: 29 years	Quadriceps	Monophasic pulses. Frequency = 30 Hz, width = 400 μs. Amplitude set to where individuals could lift a 3lb load through 75% range of motion.
Figoni [27]	14 individuals with spinal cord injuries; age: 32 years	Quadriceps	Biphasic square pulses. Frequency = 35 Hz, width = 300 μs, amplitude = 150 mA. Completed a 4 minute protocol performing knee extensions with each a 0, 5, 10, and 15 kg load.
Miyamoto [41]	18 individuals with type 2 diabetes (10M, 8F); age: 64 years	Quadriceps, hamstrings, and gluteal muscles	Monophasic square pulses. Frequency = 4 Hz, width = 200 μs. Amplitude set to reach 6.0 ml/kg/min. 30 minute protocol.
Kimura [34]	10 obese and 4 pre-obese males; age 45 years	Quadriceps, hamstrings, and gluteal muscles	Monophasic square pulses. Frequency = 4 Hz, width = 200 μs. Amplitude set to maximal level without discomfort.
Miyamoto [40]	11 males with type 2 diabetes; age: 57 years	Quadriceps, hamstrings, and gluteal muscles	Monophasic square pulses. Frequency = 4 Hz, width = 200 μs. Amplitude set to maximal without discomfort. 30 minute protocol.
Poole [18]	33 individuals with type 2 diabetes (16M, 17F); age: 55 years	Quadriceps and abdominal muscles	Frequency = 50 Hz. Amplitude was set to a max of 40 mA which equated to about 10% MVC. Performed 8 seconds contractions.
Teschler [45]	16 healthy individuals (13M, 3F); age: 33.5 years	Upper legs, upper arms, gluteals, abdomen, chest, lower back, upper back, latissimus dorsi	Frequency = 35 Hz, width = 350 μs, duty cycle on:off = 7:4. Performed 1-2 sets of 6-8 repetitions for 8 different movements. Amplitude increased to achieve a perceived exertion of 7-8 (very hard, to very hard+). 20 minute protocol.

Table 2. Study quality assessment

Reference	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total
Abitante [24]	1	1	1	0	0	1	1	0	0	1	6
Ashley [25]	1	0	1	1	0	1	1	0	0	1	6
Banerjee [17]	1	1	1	0	0	1	1	0	1	1	7
Chen [26]	1	1	1	1	0	1	1	0	1	1	8
Fornusek [28]	1	0	1	1	0	1	1	0	1	1	7
Grosset [30]	1	1	1	1	0	1	1	0	1	1	8
Galvan [29]	1	1	1	1	0	1	1	0	1	1	8
Hamada [32]	1	0	1	0	0	1	0	0	1	1	5
Hamada [31]	1	1	1	0	0	1	1	0	1	1	7
Hirata [33]	1	0	1	0	0	1	1	0	1	1	6
Hsu [13]	1	0	1	0	1	1	1	0	0	1	6
Isakov [14]	1	1	1	0	0	1	1	0	1	0	6
Janssen [19]	1	0	1	0	0	1	1	0	1	1	6
Lago [35]	1	1	1	1	0	1	1	0	1	1	8
Laskin [36]	1	0	1	0	0	0	1	0	1	1	5
Ma [23]	1	1	1	1	0	0	1	0	1	1	7
Matsushima [37]	1	1	1	1	0	1	1	0	1	1	8
Minogue [39]	1	0	1	0	0	1	1	0	1	0	5
Minogue [38]	1	0	1	0	0	1	1	0	1	1	6
Miyamoto [42]	1	0	1	0	0	1	1	0	1	1	6
Perez-De-Arrilucea-Le-Floc'h [20]	1	1	1	0	0	1	1	0	1	1	7
Sillen [10]	1	0	1	0	0	1	1	0	0	1	5
Sillen [21]	1	1	1	0	1	1	1	0	1	1	8
Takeda [44]	1	1	1	0	0	1	1	0	1	1	7
Theurel [46]	1	0	1	0	0	1	1	0	1	1	6
Tseh [47]	1	1	1	1	1	1	1	0	1	1	9
Valli [15]	1	1	1	0	0	1	0	0	1	0	5
Woelfel [22]	1	1	1	1	0	1	1	0	1	1	8
Zinner [48]	1	0	1	0	0	1	1	0	1	1	6
Pollack [43]	1	1	1	1	0	1	1	0	1	1	8
Figoni [27]	1	0	1	1	0	1	1	0	1	1	7
Miyamoto [41]	1	0	1	0	1	1	1	0	1	1	7
Kimura [34]	1	0	1	0	0	1	1	0	1	1	6
Miyamoto [40]	1	0	1	0	0	1	1	0	1	1	6
Poole [18]	1	1	1	0	1	1	0	0	1	1	7
Teschler [45]	1	1	1	1	1	1	1	0	1	1	9

Q1: Was the study question or objective clearly stated?
Q2: Were eligibility/selection criteria for the study population prespecified and clearly described?
Q3: Were the participants in the study representative of those who would be eligible for the test/service/intervention in the general or clinical population of interest?
Q4: Were all eligible participants that met the prespecified entry criteria enrolled?
Q5: Was the sample size sufficiently large to provide confidence in the findings?
Q6: Was the test/service/intervention clearly described and delivered consistently across the study population?
Q7: Were the outcome measures prespecified, clearly defined, valid, reliable, and assessed consistently across all study participants?
Q8: Were the people assessing the outcomes blinded to the participants' exposures/interventions?
Q9: Was the loss to follow-up after baseline 20% or less? Were those lost to follow-up accounted for in the analysis?
Q10: Did the statistical methods examine changes in outcome measures from before to after the intervention? Were statistical tests done that provided p values for the pre-to-post changes?