NHS England Evidence Review:

Myoelectric control multi-grip upper limb prosthetics for congenital upper limb deficiency or upper limb amputation

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Contents

1. Introduction

This evidence review examines the clinical effectiveness, safety and cost effectiveness of myoelectric control multi-grip upper limb prosthetics compared to standard[1] upper limb prosthetics without myoelectric control multi-grip function or no prosthetic use in patients with congenital upper limb deficiency or acquired upper limb amputation. Myoelectric control multi-grip prosthetics that are commercially available in the UK were eligible for inclusion.

Myoelectric control multi-grip upper limb prosthetics are powered by an external battery power source. The mechanism allows multiple grip patterns through multiple articulations in the prosthetic. They are controlled through coordinated patterns of muscular movement in the remaining limb. The thumb and digits can move independently from each other. The thumb might be manually operated or powered dependent on the device.

Passive functional prosthetics have no intrinsic active moving parts and are used for grasping tasks, such as supporting, stabilising, pushing or pulling. The digits are positioned but act in a passive shape. Single grip prosthetics have a limited range of motion and the digits or thumb are not independently controlled. Terminal device prosthetics can be designed for a specific activity e.g. playing a sport.

A non-myoelectric control multi-grip upper limb prosthetic has a mechanism which allows multiple grip patterns though multiple articulations in the prosthetic. It is controlled through muscular movement in the remaining limb/hand or finger and/or controlled by the opposite side. The thumb and digits may move independently from each other to allow more than a single grip pattern. The device is not powered by an external battery source (e.g. it is not a myoelectric device).

In addition, the review scope included the identification of possible subgroups of patients within the included studies who might benefit from the myoelectric control multi-grip upper limb prosthetic more than others.

[1] The term ‘standard’ includes passive functional prosthetics, body powered single grip devices, terminal devices, myoelectric single grip devices and non-myoelectric control multi-grip devices. Hand, partial hand or digit prosthetics are included

2. Executive summary of the review

Six papers were included in this review (Luchetti et al 2015, Resnik et al 2020a, Resnik et al 2020b, Resnik et al 2020c, Resnik et al 2020d, Salminger et al 2019). Three papers reported the results of studies and three papers reported the results of surveys. Together, these provided data comparing myoelectric multi-grip prosthetics to single grip prosthetics or no prosthetic use. The six included papers were:

- One longitudinal crossover study (Luchetti et al 2015, n=6) comparing outcomes for unilateral transradial amputees using their existing myoelectric single grip prosthetic at baseline with a myoelectric multi-grip prosthetic after three months (functional assessment) and six months (psychosocial assessment). This study also provided non-comparative data for one outcome (device durability) for the myoelectric multi-grip prosthetic.

- One cross-sectional study (Salminger et al 2019) comparing outcomes for unilateral below elbow amputees who use a myoelectric multi-grip (n=5) or a myoelectric single grip (n=8) prosthetic.

- One cross-sectional study (Resnik et al 2020b) comparing outcomes for users of myoelectric multi-grip prosthetics (n=25), myoelectric single grip prosthetics (n=27) or body powered single grip prosthetics (n=75). Participants included unilateral (n=112) and bilateral (n=15) amputees and outcomes were reported separately for transradial (n=87) and transhumeral amputees (n=35)[2].

- Two papers reporting different outcomes from the same cross-sectional survey of veterans with unilateral upper limb amputation who use different types of prosthetic (Resnik et al 2020c, Resnik et al 2020d). These papers reported different outcomes as different comparisons with myoelectric multi-grip prosthetics (n=40): namely, vs myoelectric single grip (n=30); vs body powered single grip (n=325) and vs any single grip (n=364)[3]. One functional outcome measure was also reported as a comparison between myoelectric multi-grip prosthetic users (n=40) wearing their prosthetic vs not using a prosthetic.

- One longitudinal survey of veterans with upper limb amputation which surveyed participants twice 12 months apart (Resnik et al 2020a). This paper reported data on prosthetic abandonment for users of myoelectric multi-grip (n=33), myoelectric single grip (n=30) or body powered single grip (n=323) prosthetics.

Research Question 1:

1. In adults and children with either congenital upper limb deficiency or acquired upper limb amputation, what is the clinical effectiveness of the myoelectric control multi-grip

[2] 5 participants with amputation at the shoulder level were included in the study population figures but not in the outcomes by prosthetic type reported by the study authors
[3] In the comparison with any single grip prosthetic, 9 participants where the single grip device model was unknown (i.e. whether it was a myoelectric or body powered prosthetic) were included

upper limb prosthetic compared with standard[4] upper limb prosthetics or no prosthetic use?

Critical outcomes

The critical outcomes for decision making are functional outcome measures, activities of daily living and quality of life. The certainty of the evidence for all critical outcomes was very low when assessed using modified GRADE.

Functional outcome measures

Four papers (Luchetti et al 2015, Salminger et al 2019, Resnik et al 2020b, Resnik et al 2020c) provided evidence relating to functional outcome measures, including four different comparisons.

Myoelectric multi-grip vs myoelectric single grip

For people with transradial upper limb amputation, there was a statistically significant benefit for a myoelectric multi-grip prosthetic compared to a myoelectric single grip prosthetic in one longitudinal crossover study (Luchetti et al 2015) and no statistically significant difference between myoelectric multi-grip prosthetic users and myoelectric single grip prosthetic users in one cross-sectional study (Salminger et al 2019):

- Luchetti et al 2015 (n=6) reported a statistically significant benefit for a myoelectric multi-grip prosthetic at three months compared to a myoelectric single grip prosthetic at baseline for three functional outcome measures: the Box and Block Test (BBT)[5] (median 29.0 (range 26 to 33) vs 24.0 (19 to 30), $p<0.05$); the Minnesota Manual Dexterity Test (MMDT)[6] (138.5 (120 to 165) vs 162.5 (130 to 297), $p<0.05$); the Southampton Hand Assessment Procedure (SHAP)[7] index of functionality (83.0 (76 to 88) vs 74.5 (43 to 84), $p<0.05$). For the BBT, the authors stated that four of six participants showed an improvement (with the multi-grip prosthetic) larger than the "minimum detectable change" (≥6.46). Another scale, the Orthotics and Prosthetics User Survey-Upper Extremity Functional Status (OPUS-UEFS)[8], was reported to show "an easier execution of activities of daily living" at three months by five of the six participants (from -0.48 to -8.86 points). Participants were also reported to show "low Disabilities of the Arm, Shoulder and Hand (DASH)[9] scores in all assessments, with values always lower than 26 points", indicating high functionality. Differences

[4] The term 'standard' includes passive functional prosthetics, body powered single grip devices, terminal devices, myoelectric single grip devices and non-myoelectric control multi-grip devices. Hand, partial hand or digit prosthetics are included
[5] The Box and Block Test assesses arm/hand dexterity through the number of wooden blocks moved from one area to another in 1 minute. Higher scores indicate higher functionality
[6] MMDT assesses arm/hand dexterity through the time taken (in seconds) to place 60 round pegs into holes. Lower scores indicate higher functionality
[7] SHAP assesses hand dexterity in 12 abstract object tasks and 14 activities of daily living. Time in seconds to complete each task is inputted into a scoring chart that calculates an overall index of functionality. Higher scores indicate higher functionality
[8] OPUS-UEFS assesses upper limb physical function in activities of daily living using a 23-item self-report questionnaire. Scores range from 0 to 100 with lower scores indicating higher functionality
[9] DASH assesses upper limb physical function in activities of daily living using a 30-item self-report questionnaire (DASH is listed as a functional outcome measure in the PICO). Scores range from 0 (no disability) to 100 (most severe disability) with lower scores indicating higher functionality. The PICO states that the minimally clinical important difference is an improvement in DASH score of >14

between assessments were reported to be “smaller than the minimum detectable change (10.7 points)”. The study authors did not provide any further details relating to this result.

- Salminger et al 2019 reported no statistically significant difference between users of a myoelectric multi-grip prosthetic (n=5) and users of a myoelectric single grip prosthetic (n=8) for four functional outcome measures: BBT (p=0.486); the Clothespin-relocation test (CPRT)[10] (p=0.758); SHAP (p=0.142); Action Research Arm Test (ARAT)[11] (p=0.243). No further details were reported.

Myoelectric multi-grip vs myoelectric single grip vs body powered single grip

For people with upper limb amputation, the results of four different measures differed in a comparison across users of three types of prosthetic in one cross-sectional study (Resnik et al 2020b). In this study, results were reported for all transradial (TR) amputees (unilateral and bilateral) and all transhumeral (TH) amputees for three measures[12]. For the fourth measure (QuickDASH[13]), results were only reported for unilateral TR and TH amputees:

- Resnik et al 2020b reported a statistically significant difference across the three prosthetic types for TR and TH amputees for one functional outcome measure: the Nine Hole Peg Test[14] (mean items per second (standard deviation (SD)) TR: myoelectric multi-grip (n=19) 0.01 (0.01), myoelectric single grip (n=15) 0.06 (0.06), body powered single grip (n=53) 0.07 (0.06), p=0.0001; TH: myoelectric multi-grip (n=5) 0.00 (0.00), myoelectric single grip (n=10) 0.01 (0.03), body powered single grip (n=20) 0.05 (0.06), p=0.031[15])

- On another measure (BBT), Resnik et al 2020b reported a statistically significant difference across the three prosthetic types for TR amputees (mean (SD) myoelectric multi-grip (n=19) 15.4 (6.0), myoelectric single grip (n=15) 15.1 (9.1), body powered single grip (n=53) 20.6 (9.2), p=0.02), but no statistically significant difference for TH amputees (mean (SD) myoelectric multi-grip (n=5) 7.6 (6.5), myoelectric single grip (n=10) 5.2 (5.7), body powered single grip (n=20) 11.8 (9.8), p=0.21)

- Resnik et al 2020b reported no statistically significant difference across the three prosthetic types for two measures: SHAP index of functionality (mean (SD) TR: myoelectric multi-grip (n=19) 39.6 (14.8), myoelectric single grip (n=15) 41.0 (21.1), body powered single grip (n=53) 44.0 (19.6), p=0.57; TH: myoelectric multi-grip (n=5) 12.8 (12.7), myoelectric single grip (n=10) 10.8 (16.6), body powered single grip (n=20) 14.4 (15.3), p=0.67); QuickDASH (mean (SD) TR: myoelectric multi-grip (n=18) 26.3 (18.1), myoelectric single grip (n=12) 30.9 (15.8), body powered single

[10] CPRT assess functionality through the time taken to transfer 4 clothespins of various strengths from a horizontal bar to a vertical one. Lower scores indicate higher functionality
[11] ARAT assesses upper limb motor function through 4 sections with different tasks with a maximum score of 57 points. Higher scores indicate higher functionality
[12] Results were also reported for unilateral amputees only. These are discussed under the subgroup question
[13] QuickDASH is a self-report questionnaire assessing difficulty performing activities, amount of limitation, extent of interference with activities and extent of arm, shoulder and hand pain and tingling. Scores range from 1 (very easy) to 5 (cannot do at all) with lower scores indicating higher functionality
[14] The Nine Hole Peg Test assesses arm/hand dexterity through the time taken to accurately place and remove 9 pegs into and from a pegboard. Mean score calculated as items per second. Higher scores indicate higher functionality
[15] This result was statistically significant at a $p<0.05$, but no longer significant after controlling for multiple comparisons

grip (n=45) 29.2 (19.4), p=0.72); TH: myoelectric multi-grip (n=5) 30.5 (13.3), myoelectric single grip (n=9) 28.2 (13.8), body powered single grip (n=18) 34.0 (20.7), p=0.85).

The table below summarises the functional outcome measure results listed above for this study[16]:

Table A: Summary of the Resnik et al 2020b functional outcome measure results

Measure	Population	Myoelectric multi-grip	Myoelectric single grip	Body powered single grip	p
Nine Hole Peg Test (mean items per second (SD))	TR amputees	0.01 (0.01)	0.06 (0.06)	0.07 (0.06)	p=0.0001
	TH amputees	0.00 (0.00)	0.01 (0.03)	0.05 (0.06)	p=0.031
BBT (mean blocks moved in 1 minute (SD))	TR amputees	15.4 (6.0)	15.1 (9.1)	20.6 (9.2)	p=0.02
	TH amputees	7.6 (6.5)	5.2 (5.7)	11.8 (9.8)	p=0.21
SHAP index of functionality (mean score (SD))	TR amputees	39.6 (14.8)	41.0 (21.1)	44.0 (19.6)	p=0.57
	TH amputees	12.8 (12.7)	10.8 (16.6)	14.4 (15.3)	p=0.67
QuickDASH (mean score (SD))	TR amputees	26.3 (18.1)	30.9 (15.8)	29.2 (19.4)	p=0.72
	TH amputees	30.5 (13.3)	28.2 (13.8)	34.0 (20.7)	p=0.85
Abbreviations: BBT: Box and Block Test, QuickDASH: Quick Disabilities of the Arm, Shoulder and Hand, SD: standard deviation, SHAP: Southampton Hand Assessment Procedure, TH: transhumeral, TR: transradial					

Myoelectric multi-grip vs body powered single grip

For people with upper limb amputation, there was no statistically significant difference between myoelectric multi-grip prosthetic users (n=40) and body powered single grip prosthetic users (n=325) in one cross-sectional survey (Resnik et al 2020c): multi-variate linear regression modelling for QuickDASH β 1.24 (95% confidence interval (CI) -5.88 to 8.36) (p=0.7326).

Myoelectric multi-grip vs no prosthetic use

For people with upper limb amputation, there was no statistically significant difference between myoelectric multi-grip prosthetic users (n=40) wearing their prosthetic compared to no prosthetic use for the performance of two-handed tasks in one cross-sectional survey. However, there was a statistically significant benefit in using a myoelectric multi-grip prosthetic compared to no prosthetic use for the performance of one-handed tasks (Resnik et al 2020c):

- Resnik et al 2020c reported no statistically significant difference for the self-reported performance of two-handed tasks using a myoelectric multi-grip prosthetic vs no prosthetic use: QuickDASH tasks mean (±SD) (lift and carry bulky objects: 2.8±1.3 vs 2.7±1.1, p=0.67; spread peanut butter: 3.1±1.4 vs 3.3±1.3, p=0.60; do housework: 2.5±1.1 vs 2.8±1.2, p=0.12).

- Resnik et al 2020c reported a statistically significantly better self-reported performance of one-handed tasks using a myoelectric multi-grip prosthetic vs no

[16] A table summarising these results has been added in response to a specific request from the NHS England Policy Working Group

prosthetic use (i.e. using the remaining residual limb): QuickDASH tasks mean (±SD) (pick up small objects: 3.5±1.1 vs 4.5±1.1, p=0.0008; grasp rounded objects (2.6±1.2 vs 4.1±1.2, p<0.0001).

Activities of daily living

Two papers (Resnik et al 2020b, Resnik et al 2020c) provided evidence relating to activities of daily living, including two different comparisons.

Myoelectric multi-grip vs myoelectric single grip vs body powered single grip

For people with unilateral upper limb amputation, there was no statistically significant difference for all but one measure in a comparison across the users of three types of prosthetic in one cross-sectional study (Resnik et al 2020b):

- Resnik et al 2020b reported a statistically significant difference across the three prosthetic types for one measure of activities of daily living for TR amputees but not for TH amputees: Brief Activities Measure for Upper Limb Amputation (BAM-ULA)[17] (mean (SD) TR: myoelectric multi-grip (n=18) 8.0 (1.6), myoelectric single grip (n=12) 9.2 (1.0), body powered single grip (n=45) 6.6 (2.1), p=0.002); TH: myoelectric multi-grip (n=5) 3.5 (0.7), myoelectric single grip (n=9) 4.0 (not stated), body powered single grip (n=18) 4.5 (3.4), p=0.83).

- Resnik et al 2020b reported no statistically significant difference across the three prosthetic types for TR or TH amputees for two measures of activities of daily living: Activities Measure for Upper Limb Amputation (AM-ULA)[18] (mean (SD) TR: myoelectric multi-grip (n=18) 16.4 (6.5), myoelectric single grip (n=12) 14.9 (7.7), body powered single grip (n=45) 14.9 (5.3), p=0.68); TH: myoelectric multi-grip (n=5) 11.9 (1.8), myoelectric single grip (n=9) 9.4 (4.2), body powered single grip (n=18) 12.3 (6.2), p=0.23); Timed Measure of Activity Performance (T-MAP)[19] (mean (SD) TR: myoelectric multi-grip (n=18) 3.9 (0.9), myoelectric single grip (n=12) 3.9 (0.6), body powered single grip (n=45) 5.0 (1.8), p=0.081); TH: myoelectric multi-grip (n=5) 7.4 (3.0), myoelectric single grip (n=9) 4.9 (1.2), body powered single grip (n=18) 4.6 (1.7), p=0.18).

- Resnik et al 2020b also reported no statistically significant difference in the percentage of users needing help with daily activities (TR: myoelectric multi-grip (n=18) 16.7%, myoelectric single grip (n=12) 37.5%, body powered single grip (n=45) 21.2%, p=0.57); TH: myoelectric multi-grip (n=5) 20%, myoelectric single grip (n=9) 28.6%, body powered single grip (n=18) 25%, p=1.0).

Myoelectric multi-grip vs body powered single grip

For people with upper limb amputation, there was no statistically significant difference between myoelectric multi-grip prosthetic users (n=40) and body powered single grip prosthetic users (n=325) in one cross-sectional survey (Resnik et al 2020c): multi-variate

[17] BAM-ULA is an assessment of ability to complete 10 everyday tasks. Total score is the number of completed activities with higher scores indicating better performance
[18] AM-ULA is an assessment of activity performance for 18 everyday tasks. Each task is rated on task completion, speed, movement, quality, skilfulness of prosthetic use and independence. Total score is the average score x 10 with higher scores indicating better performance
[19] T-map is an assessment of time taken to complete 5 everyday activities. Lower scores indicate better performance

logistic modelling for help needed with daily activities (odds ratio (OR) 1.75 (95%CI 0.81 to 3.79) (p=0.1557).

Quality of life

Three papers (Luchetti et al 2015, Resnik et al 2020b, Resnik et al 2020c) provided evidence relating to quality of life, including three different comparisons.

Myoelectric multi-grip vs myoelectric single grip

For people with transradial upper limb amputation, there was no statistically significant difference between myoelectric multi-grip prosthetics at six months and myoelectric single grip prosthetics at baseline for two quality of life measures in one longitudinal crossover study: EURO Quality of Life Questionnaire 5 Dimensions (EURO-QoL EQ-5D)[20] (summary index median (range) 0.858 (0.539 to 0.919) vs 0.901 (0.796 to 0.919), p >0.05; visual analogue scale 90.0 (70 to 100) vs 87.5 (70 to 100), p>0.05); Hospital Anxiety and Depression Scale (HADS)[21] (anxiety 2.0 (0 to 9) vs 2.0 (0 to 7), p>0.05; depression (3.5 (0 to 6) vs 2.5 (1 to 5), p>0.05) (Luchetti et al 2015, n=6).

Myoelectric multi-grip vs myoelectric single grip vs body powered single grip

For people with unilateral upper limb amputation, there was no statistically significant difference in a comparison across users of three types of prosthetic in one cross-sectional study (Resnik et al 2020b):

- Resnik et al 2020b reported no statistically significant difference across the three prosthetic types for one measure of quality of life with results reported separately for TR and TH amputees: Veterans 12-item Health Survey (VR-12)[22] (mental component summary mean (SD) TR: myoelectric multi-grip (n=18) 52.4 (11.5), myoelectric single grip (n=12) 46.3 (12.8), body powered single grip (n=45) 53.5 (10.1), p=0.085, TH: myoelectric multi-grip (n=5) 52.9 (9.4), myoelectric single grip (n=9) 50.6 (14.6), body powered single grip (n=18) 50.4 (13.1), p=0.98; VR-12 physical component summary mean (SD) TR: myoelectric multi-grip (n=18) 41.1 (8.2), myoelectric single grip (n=12) 43.2 (6.9), body powered single grip (n=45) 37.5 (8.9), p=0.085), TH: myoelectric multi-grip (n=5) 44.0 (8.1), myoelectric single grip (n=9) 41.9 (5.6), body powered single grip (n=18) 34.7 (13.2), p=0.17).

Myoelectric multi-grip vs body powered single grip

For people with upper limb amputation, there was no statistically significant difference between myoelectric multi-grip prosthetic users (n=40) and body powered single grip prosthetic users (n=325) in one cross-sectional survey: multi-variate linear regression modelling for one measure of quality of life: VR-12 mental component β 2.59 (95%CI -2.14

[20] EuroQoL EQ-5D assesses self-reported health-related quality of life for 5 items (mobility, self-care, usual activities, pain and discomfort, and anxiety and depression). A summary index scored from 0 to 1 and a visual analogue scale from 0 to 100 were used to rate perceived health status. Higher scores indicate higher quality of life

[21] HADS assesses anxiety and depression using a 14-item self-report questionnaire. Scores range from 0 to 21 with lower scores indicating less anxiety or depression. The authors gave a cut-off of ≥ 8 for considering participants to be anxious or depressed

[22] The VR-12 is a 12-item self-report questionnaire assessing health-related quality of life. Scores range from 1 to 100 with higher scores indicating higher quality of life

to 7.32) (p=0.2825); VR-12 physical component β -0.97 (95%CI -3.99 to 2.05) (p=0.5295) (Resnik et al 2020c).

Important outcomes

The important outcomes for decision making are prosthetic abandonment, patient satisfaction and prosthetic acceptability, device durability and frequency of replacement and/or re-fitting. The certainty of the evidence for all important outcomes was very low when assessed using modified GRADE.

Prosthetic abandonment

One longitudinal survey (Resnik et al 2020a) reported data relating to prosthetic abandonment in people with upper limb amputation. The percentage of respondents who were using a different prosthetic in the 12-month follow-up survey compared to the prosthetic that they had been using in the baseline survey was reported for different baseline device types (no statistical test reported):

- Myoelectric multi-grip (n=33): 58%
- Body powered single grip (n=232): 20%
- Myoelectric single grip (powered hook) (n=14): 43%
- Myoelectric single grip (Sensor speed) (n=10): 40%
- Myoelectric single grip (Greifer) (n=6): 67%

Patient satisfaction and prosthetic acceptability

Three papers (Luchetti et al 2015, Resnik et al 2020b, Resnik et al 2020d) provided evidence relating to patient satisfaction and prosthetic acceptability, including three different comparisons.

Myoelectric multi-grip vs myoelectric single grip

For people with upper limb amputation, there was no statistically significant difference between myoelectric multi-grip prosthetics and myoelectric single grip prosthetics in one longitudinal crossover study (Luchetti et al 2015) and one cross-sectional survey (Resnik et al 2020d).

- Luchetti et al 2015 (n=6) reported no statistically significant difference between a myoelectric multi-grip prosthetic at six months compared to a myoelectric single grip prosthetic at baseline for two patient satisfaction measures: the Trinity Amputation and Prosthesis Experience Scales Satisfaction Scale (TAPES-SAT)[23] (median (range) 43 (27 to 46) vs 43 (35 to 45), p >0.05); the Amputee Body Image Scale (ABIS)[24] (median (range) 36.0 (33 to 50) vs 34.0 (33 to 48), p>0.05).

[23] TAPES-SAT is a 10-item self-report questionnaire assessing prosthetic satisfaction through colour, shape, noise, appearance, weight, usefulness, reliability, fit, comfort and overall satisfaction. Items are rated on a 5-point scale from 1 (very dissatisfied) to 5 (very satisfied) with higher scores indicating higher satisfaction
[24] ABIS assesses body image concerns using a 20-item self-report questionnaire. Scores range from 20 to 100 with lower scores indicating fewer concerns

- Resnik et al 2020d reported no statistically significant difference between myoelectric multi-grip prosthetic users (n=40) and myoelectric single grip prosthetic users (n=30) in bi-variate linear regression modelling for two patient satisfaction measures: TAPES-SAT β 0.11 (95%CI not reported) (p=0.4812); Orthotics and Prosthetics User Survey Client Satisfaction with Devices Scale (OPUS-CSD)[25] β -0.57 (95%CI not reported) (p=0.9023).

Myoelectric multi-grip vs myoelectric single grip vs body powered single grip

For people with unilateral upper limb amputation, there was no statistically significant difference in a comparison across three types of prosthetic in one cross-sectional study (Resnik et al 2020b).

- Resnik et al 2020b reported no statistically significant difference across the three prosthetic types for one measure of patient satisfaction for TR or TH amputees: TAPES-SAT (mean (SD) TR: myoelectric multi-grip (n=18) 3.8 (0.7), myoelectric single grip (n=12) 3.5 (0.7), body powered single grip (n=45) 4.0 (0.7), p=0.051); TH myoelectric multi-grip (n=5) 3.7 (0.5), myoelectric single grip (n=9) 3.5 (0.5), body powered single grip (n=18) 3.7 (0.9), p=0.64).

Myoelectric multi-grip vs any single grip (myoelectric or body powered):

For people with upper limb amputation, there was no statistically significant difference between myoelectric multi-grip prosthetic users (n=40) and single grip prosthetic users (myoelectric control or body powered) (n=364) in one cross-sectional survey in bi-variate linear regression modelling for two measures of patient satisfaction: TAPES-SAT β -0.07 (95%CI not reported) (p=0.5286); OPUS-CSD β 1.58 (95%CI not reported) (p=0.6043) (Resnik et al 2020d).

Device durability

One longitudinal crossover study (Luchetti et al 2015, n=6) reported non-comparative data on device durability. Four of six participants (66.7%) experienced at least one temporary failure of the myoelectric multi-grip prosthetic over the six-month study period. No further details were reported.

Frequency of replacement and/or re-fitting

No evidence was identified for this outcome.

Research question 2

2. In adults and children with either congenital upper limb deficiency or acquired upper limb amputation, what is the safety of the myoelectric control multi-grip upper limb prosthetic compared with standard upper limb prosthetic use or no prosthetic use?

[25] A modified version of the OPUS-CSD self-report questionnaire was used with 8-items assessing prosthetic satisfaction through fit, weight, comfort, donning ease, appearance, durability, skin irritation and pain. Items are rated on a 4-point scale from 1 (strongly agree) to 4 (strongly disagree) with lower scores indicating higher satisfaction

No evidence was identified on the safety of the myoelectric control multi-grip upper limb prosthetic compared with standard upper limb prosthetics or no prosthetic use.

Research question 3

3. In adults and children with either congenital upper limb deficiency or acquired upper limb amputation, what is the cost effectiveness of the myoelectric control multi-grip upper limb prosthetic compared with standard upper limb prosthetic use or no prosthetic use?

No evidence was identified on the cost effectiveness of the myoelectric control multi-grip upper limb prosthetic compared with standard upper limb prosthetics or no prosthetic use.

Research question 4

4. From the evidence selected, are there any subgroups of patients that may benefit from the myoelectric control multi-grip upper limb prosthetic more than the wider population of interest?

No evidence was identified regarding any subgroups of patients that would benefit more from treatment with a myoelectric multi-grip prosthetic.

Four of the six included papers only included participants with unilateral amputation (Luchetti et al 2015, Resnik et al 2020c, Resnik et al 2020d, Salminger et al 2019). The remaining two papers included both unilateral and bilateral amputees (Resnik et al 2020a, Resnik et al 2020b). Resnik et al 2020a pooled the results of unilateral and bilateral amputees for the only outcome that they reported by type of prosthetic. Resnik et al 2020b reported three functional outcome measures separately for all participants (both unilateral and bilateral amputees) and for unilateral amputees only. Four papers included participants with different levels of amputation (Resnik et al 2020a, Resnik et al 2020b, Resnik et al 2020c, Resnik et al 2020d), but only one paper (Resnik et al 2020b) reported outcomes separately for transradial and transhumeral amputees. However, although some outcomes were reported separately in some studies, the pattern of results was similar for the different populations. No statistical tests of difference in effect between unilateral and bilateral amputees or between transradial or transhumeral amputees were reported.

Discussion

Certainty in the outcomes reported by the included papers was limited by several factors. None of the papers included randomisation of participants to prosthetic type or, in the case of the longitudinal crossover study, to the order in which participants were tested using the different prosthetics. In the latter case this introduces the possibility of a practice effect from experience of the assessments using the single grip prosthetic before completing the assessments with the multi-grip prosthetic. In five of the six papers, participants were assessed using their own existing prosthetic. User need may determine choice of prosthetic and the authors did not always account for potential confounding factors, so the comparisons between types of prosthetic should be interpreted with caution. Several of the outcome measures reported by studies assess more than one domain or type of skill/ability. This further complicates the interpretation of the results. In all the included papers, outcomes were assessed at a single measurement point or a single timepoint providing a snapshot of functional ability or self-reported quality of life and satisfaction at that time. Caution should be exercised in drawing wider, longer-term conclusions.

Most participants were male adults and, in four of the papers, participants were all or mostly American veterans. The study dates were not always stated. The response rate in the cross-sectional survey was 48%. People who chose to participate in the survey may not be representative of the wider population targeted by the survey. Specific details about the populations of all the individual studies and surveys was lacking (e.g. demographics, occupation, training and support received). The population information that was available was not reported in a way that could be used to interpret the results, for example in relation to subgroups of the study populations. The multi-grip and single grip prosthetics used by participants varied with some papers reporting results for a specific prosthetic model and others pooling results for prosthetics by type of grip. The generalisability of the results is not clear.

No studies reported data directly comparing myoelectric control multi-grip prosthetics to non-myoelectric control multi-grip prosthetics, to cosmetic or terminal device prosthetics or to amputees who do not use a prosthetic.

Conclusion

Very low certainty evidence for an additional benefit for a myoelectric control multi-grip prosthetic compared to myoelectric single grip prosthetics was found for one critical outcome (functional outcome measures) in one longitudinal crossover study where the same participants were tested using different prosthetics. However, in this study there was no statistically significant difference between prosthetics in other critical (quality of life) and important (patient satisfaction and prosthetic acceptability) outcomes. Four cross-sectional studies or surveys comparing critical and important outcomes in users of different prosthetics did not identify a benefit for myoelectric control multi-grip prosthetics compared to single grip prosthetics (very low certainty). In the one cross-sectional study reporting a statistically significant difference for two functional outcome measures and one activities of daily living measure, the better mean scores were for users of single grip prosthetics. One survey provided very low certainty evidence for a benefit for a myoelectric multi-grip prosthetic compared to no prosthetic use for one-handed tasks using the remaining residual limb. No statistical comparison between prosthetic type was available for the important outcome of prosthetic abandonment and no comparative evidence was available for the important outcome of device durability. No evidence was identified for the important outcomes of frequency of replacement and/or re-fitting or safety.

No evidence was identified regarding any subgroups of patients that would benefit more from treatment with a myoelectric multi-grip prosthetic. No evidence was identified on cost effectiveness.

Further research, preferably involving the randomisation of participants to different groups, is required to further understand the clinical effectiveness, safety and cost effectiveness of myoelectric multi-grip prosthetics compared to standard prosthetics.

3. Methodology

Review questions

The review questions for this evidence review are:

1. In adults and children with either congenital upper limb deficiency or acquired upper limb amputation, what is the clinical effectiveness of the myoelectric control multi-grip upper limb prosthetic compared with standard upper limb prosthetics or no prosthetic use?
2. In adults and children with either congenital upper limb deficiency or acquired upper limb amputation, what is the safety of the myoelectric control multi-grip upper limb prosthetic compared with standard upper limb prosthetic use or no prosthetic use?
3. In adults and children with either congenital upper limb deficiency or acquired upper limb amputation, what is the cost effectiveness of the myoelectric control multi-grip upper limb prosthetic compared with standard upper limb prosthetic use or no prosthetic use?
4. From the evidence selected, are there any subgroups of patients that may benefit from the myoelectric control multi-grip upper limb prosthetic more than the wider population of interest?

See Appendix A for the full review protocol.

Review process

The methodology to undertake this review is specified by NHS England in their 'Guidance on conducting evidence reviews for Specialised Services Commissioning Products' (2019).

The searches for evidence were informed by the PICO document and were conducted on 11th November 2020.

See Appendix B for details of the search strategy.

Results from the literature searches were screened using their titles and abstracts for relevance against the criteria in the PICO framework. Full text references of potentially relevant evidence were obtained and reviewed to determine whether they met the inclusion criteria for this evidence review.

See Appendix C for evidence selection details and Appendix D for the list of studies excluded from the review and the reasons for their exclusion.

Relevant details and outcomes were extracted from the included studies and were critically appraised using a checklist appropriate to the study design. See Appendices E and F for individual study and checklist details.

The available evidence was assessed by outcome for certainty using modified GRADE. See Appendix G for GRADE Profiles.

4. Summary of included studies

Six papers were identified for inclusion (Luchetti et al 2015, Resnik et al 2020a, Resnik et al 2020b, Resnik et al 2020c, Resnik et al 2020d, Salminger et al 2019). Three papers reported the results of studies and three papers reported the results of surveys. Table 1 provides a summary of these included papers and full details are given in Appendix E. One was a longitudinal crossover study (Luchetti et al 2015), two were cross-sectional studies (Salminger et al 2019, Resnik et al 2020b), two reported different outcomes from the same cross-sectional survey (Resnik et al 2020c, Resnik et al 2020d) and one was a longitudinal survey (Resnik et al 2020a).

These papers included data comparing myoelectric multi-grip prosthetics with single grip prosthetics. One of these papers (Resnik et al 2020c) also included a comparison between myoelectric multi-grip prosthetic users wearing their prosthetic vs not using a prosthetic.

No studies reported data directly comparing myoelectric control multi-grip prosthetics to non-myoelectric control multi-grip prosthetics, to cosmetic or terminal device prosthetics or to amputees who do not use a prosthetic. No cost effectiveness studies were identified.

Table 1: Summary of included studies

Study	Population	Intervention and comparison	Outcomes reported

Luchetti et al 2015
 	
Longitudinal crossover study
 	
Italy
	6 participants with unilateral transradial upper limb amputation
	
	No subgroups reported
		Intervention Myoelectric multi-grip prosthetic hand (Michelangelo) assessed at 3 months or 6 months
		
		Comparison
		
		Baseline tests using the participant's existing myoelectric single grip prosthetic hand
		
		Duration of use of the existing single grip prosthetic not reported
			Critical outcomes
			• Functional outcome measures (3 months)
			  • BBT
			  • MMDT
			  • SHAP
			  • DASH
			  • OPUS-UEFS
			• Quality of life (6 months)
			  • EuroQoL EQ-5D
			  • HADS
			Important outcomes
			• Patient satisfaction and prosthetic acceptability (6 months)
			  • TAPES-SAT
			  • ABIS
			• Device durability (6 months)

Resnik et al 2020a **Longitudinal survey** **USA**	585 participants with upper limb amputation Outcomes by prosthetic type extracted (n=295)	**Intervention** Myoelectric multi-grip prosthetic (I-limb, Michelangelo and Bebionic hands) (n=33) **Comparison** Single grip prosthetic:	**Important outcomes** • Prosthetic abandonment at 12 months

	No subgroups reported	• Myoelectric single grip (n=30) • Body powered single grip (n=232) Duration of use of the prosthetic types not reported	

Resnik et al 2020b
 	
Cross-sectional study
 	
USA
	127 participants with upper limb amputation
	
	Outcomes reported separately for transradial and transhumeral amputees
	
	No analysis of difference in effect between subgroups
		Intervention Myoelectric multi-grip prosthetic (I-limb, Michelangelo, Bebionic hands and LUKE arm[a]) (n=25)
		
		Comparison
		Single grip prosthetic:
		• Myoelectric single grip (n=27)
		• Body powered single grip (n=75)
		
		Duration of use of the prosthetic types not reported
			Critical outcomes
			• Functional outcome measures (all single timepoint)
			  ◦ BBT
			  ◦ Nine Hole Peg Test
			  ◦ SHAP
			  ◦ QuickDASH
			• Activities of daily living (all single timepoint)
			  ◦ AM-ULA
			  ◦ BAM-ULA
			  ◦ T-MAP
			  ◦ Help with daily activities
			• Quality of life
			  ◦ VR-12 (single timepoint)
			
			Important outcomes
			• Patient satisfaction and prosthetic acceptability
			  ◦ TAPES-SAT (single timepoint)

Resnik et al 2020c
 	
Cross-sectional survey
 	
USA
	755 participants with unilateral upper limb amputation from a national sample of veterans
	
	Outcomes by prosthetic type extracted (n=365)
	
	No subgroups reported
		Intervention Myoelectric multi-grip prosthetic (e.g. I-limb, Michelangelo and Bebionic hands) (n=40)
		
		Comparison
		Body powered single grip prosthetic[b] (n=325)
		
		Myoelectric multi-grip prosthetic users without prosthetic (n=40) (functional outcome only)
		
		Duration of use of the prosthetic types not reported
			Critical outcomes
			• Functional outcome measures
			  ◦ QuickDASH (single timepoint)
			• Activities of daily living
			  ◦ Help with daily activities (single timepoint)
			• Quality of life
			  ◦ VR-12 (single timepoint)

Resnik et al 2020d	449 participants with unilateral upper limb amputation who use a	**Intervention** Myoelectric multi-grip prosthetic (e.g. I-limb,	**Important outcomes**

Cross-sectional survey
 	
USA
	prosthetic from a national sample of veterans
	
	Outcomes by prosthetic type extracted (n=404)
	
	No subgroups reported
		Michelangelo and Bebionic hands) (n=40)
		
		Comparison
		Single grip prosthetic:
		• Myoelectric single grip (n=30)
		• Any single grip (n=364)
		
		Duration of use of the prosthetic types not reported
			• Patient satisfaction and prosthetic acceptability (all single timepoint)
			  ◦ TAPES-SAT
			  ◦ OPUS-CSD

Salminger et al 2019
 	
Cross-sectional study
 	
Country not stated
	17 participants with unilateral below elbow amputation
	
	Outcomes by prosthetic type extracted (n=13)
	
	No subgroups reported
		Intervention Myoelectric multi-grip prosthetic (Michelangelo) (n=5)
		
		Comparison
		Myoelectric single grip prosthetic (n=8)
		
		Mean (range) time using a myoelectric control prosthetic (n=17): 6.76 (1 to 16) years
			Critical outcomes
			• Functional outcome measures (all single timepoint)
			  ◦ BBT
			  ◦ CPRT
			  ◦ SHAP
			  ◦ ARAT

Abbreviations: ABIS: Amputee Body Image Scale, AM-ULA: Activities Measure for Upper Limb Amputation, ARAT: Action Research Arm Test, BAM-ULA: Brief Activities Measure for Upper Limb Amputation, BBT: Box and Block Test, CPRT: Clothespin-relocation test, DASH: Disabilities of the Arm, Shoulder and Hand, EURO-QoL EQ-5D: EURO Quality of Life Questionnaire 5 Dimensions, HADS: Hospital Anxiety and Depression Scale, MMDT: Minnesota Manual Dexterity Test, OPUS-CSD: Orthotics and Prosthetics User Survey Client Satisfaction with Devices Scale, OPUS-UEFS: Orthotics and Prosthetics User Survey-Upper Extremity Functional Status, QuickDASH: Quick Disabilities of the Arm, Shoulder and Hand, SHAP: Southampton Hand Assessment Procedure, TAPES-SAT: Trinity Amputation and Prosthesis Experience Scales Satisfaction Scale, T-MAP: Timed Measure of Activity Performance, VR-12: Veterans 12-item Health Survey			
a One of these devices, the LUKE arm, is not commercially available in the UK. The number of participants using the different types of myoelectric multi-grip devices was not stated b Type of body powered prosthetic was not reported in this paper. However, a second paper reporting results from the same survey population (Resnik et al 2020d) categorised all the body powered prosthetics as single grip hooks			

5. Results

In adults and children with either congenital upper limb deficiency or acquired upper limb amputation, what is the clinical effectiveness and safety of the myoelectric control multi-grip upper limb prosthetic compared with standard[26] upper limb prosthetics or no prosthetic use?

Outcome	Evidence statement
Clinical Effectiveness	
Critical outcomes	
Functional outcome measures **Certainty of evidence:** Very low	Functional outcomes are critical to patients as they facilitate enablement, independence and active participation. Functional outcomes include not only physical tasks but emotional, psycho-social and societal interaction. Functional outcome measures reported in the included papers were the Box and Block Test (BBT), the Minnesota Manual Dexterity Test (MMDT), the Clothespin-relocation test (CPRT), the Nine Hole Peg Test, the Southampton Hand Assessment Procedure (SHAP), the Action Research Arm Test (ARAT), Disabilities of the Arm, Shoulder and Hand (DASH), QuickDASH and Orthotics and Prosthetics User Survey-Upper Extremity Functional Status (OPUS-UEFS)[a]. In total 4 papers provided evidence relating to functional outcome measures, including 4 different comparisons: • One longitudinal crossover study compared outcomes for 6 unilateral transradial amputees using a myoelectric multi-grip prosthetic after 3 months utilisation with outcomes using their existing myoelectric single grip prosthetic at baseline (Luchetti et al 2015). • One cross-sectional study compared outcomes for unilateral below elbow amputees using a myoelectric multi-grip (n=5) or a myoelectric single grip (n=8) prosthetic (Salminger et al 2019). • One cross-sectional study compared outcomes for users of myoelectric multi-grip prosthetics (n=25), myoelectric single grip prosthetics (n=27) or body powered single grip prosthetics (n=75). This study included unilateral (n=112) and bilateral amputees (n=15) and outcomes were reported separately for transradial (n=87) and transhumeral amputees (n=35)[27] (Resnik et al 2020b). • One cross-sectional survey compared outcomes for unilateral upper limb amputees using a myoelectric multi-grip prosthetic (n=40) or a body powered single grip prosthetic (n=325) (Resnik et al 2020c). • One cross-sectional survey compared outcomes for unilateral upper limb amputees either using their myoelectric multi-grip prosthetic or no prosthetic (n=40) (Resnik et al 2020c).

[26] The term 'standard' includes passive functional prosthetics, body powered single grip devices, terminal devices, myoelectric single grip devices and non-myoelectric control multi-grip devices. Hand, partial hand or digit prosthetics are included

[27] 5 participants with amputation at the shoulder level were included in the study population figures but not in the outcomes by prosthetic type reported by the study authors

Myoelectric multi-grip vs myoelectric single grip:

- 1 longitudinal crossover study (Luchetti et al 2015, n=6) reported a *statistically significant benefit* for 3 functional outcome measures for a myoelectric multi-grip prosthetic at 3 months vs their baseline myoelectric single grip prosthetic: BBT (median 29.0 (range 26 to 33) vs 24.0 (19 to 30), p <0.05); MMDT (138.5 (120 to 165) vs 162.5 (130 to 297), p<0.05); SHAP index of functionality (83.0 (76 to 88) vs 74.5 (43 to 84), p<0.05). Another scale, the OPUS-UEFS, was reported to show "an easier execution of activities of daily living" at 3 months by 5 of the 6 participants (from -0.48 to -8.86 points). Participants were reported to show "low DASH scores in all assessments, with values always lower than 26 points", indicating high functionality. Differences between assessments were reported to be "smaller than the minimum detectable change (10.7 points)". The study authors did not provide any further details relating to this result. **(VERY LOW)**

- One cross-sectional study (Salminger et al 2019) reported *no statistically significant difference* between users of a myoelectric multi-grip prosthetic (n=5) or a myoelectric single grip prosthetic (n=8) for 4 functional outcome measures: BBT (p=0.486); CPRT (p=0.758); SHAP (p=0.142); ARAT (p=0.243). No further details reported. **(VERY LOW)**

Myoelectric multi-grip vs myoelectric single grip vs body powered single grip:

- One cross-sectional study (Resnik et al 2020b) reported comparisons across 3 prosthetic types (myoelectric multi-grip (n=25), myoelectric single grip (n=27), body powered single grip (n=75)). For 3 measures, results were reported for all transradial (TR) amputees (unilateral and bilateral) and all transhumeral (TH) amputees[28]. For one measure (QuickDASH) results were only reported for unilateral TR and TH amputees. **(VERY LOW)**:

- A *statistically significant difference* across the 3 prosthetic types was reported for TR and TH amputees for one functional outcome measure: the Nine Hole Peg Test (mean items per second (standard deviation (SD)) TR: myoelectric multi-grip (n=19) 0.01 (0.01), myoelectric single grip (n=15) 0.06 (0.06), body powered single grip (n=53) 0.07 (0.06), p=0.0001; TH: myoelectric multi-grip (n=5) 0.00 (0.00), myoelectric single grip (n=10) 0.01 (0.03), body powered single grip (n=20) 0.05 (0.06), p=0.031[29]).

- On another measure (BBT) there was a *statistically significant difference* across the 3 prosthetic types for TR amputees (mean (SD) myoelectric multi-grip (n=19) 15.4 (6.0), myoelectric single grip (n=15) 15.1 (9.1), body powered single grip (n=53) 20.6 (9.2), p=0.02), but *no statistically significant difference* for TH amputees (mean (SD) myoelectric multi-grip (n=5) 7.6 (6.5), myoelectric single grip (n=10) 5.2 (5.7), body powered single grip (n=20) 11.8 (9.8), p=0.21).

- There was *no statistically significant difference* across the 3 prosthetic types for TR or TH amputees for the SHAP index of functionality (mean (SD) TR: myoelectric multi-grip (n=19) 39.6 (14.8), myoelectric single grip (n=15) 41.0 (21.1), body powered single grip (n=53) 44.0 (19.6), p=0.57; TH: myoelectric multi-grip (n=5) 12.8 (12.7), myoelectric single grip (n=10) 10.8 (16.6), body powered single grip (n=20) 14.4 (15.3), p=0.67).

[28] Results were also reported for unilateral amputees only. These are discussed under the subgroup question
[29] This result was statistically significant at a p<0.05, but no longer significant after controlling for multiple comparisons

	• There was *no statistically significant difference* across the 3 prosthetic types for unilateral TR or TH amputees for QuickDASH (mean (SD) TR: myoelectric multi-grip (n=18) 26.3 (18.1), myoelectric single grip (n=12) 30.9 (15.8), body powered single grip (n=45) 29.2 (19.4), p=0.72); TH: myoelectric multi-grip (n=5) 30.5 (13.3), myoelectric single grip (n=9) 28.2 (13.8), body powered single grip (n=18) 34.0 (20.7), p=0.85). Myoelectric multi-grip vs body powered single grip • 1 cross-sectional survey (Resnik et al 2020c) reported *no statistically significant difference* for QuickDASH between myoelectric multi-grip prosthetic users (n=40) and body powered single grip prosthetic users (n=325) in multi-variate linear regression modelling (β 1.24 (95%CI -5.88 to 8.36) (p=0.7326). **(VERY LOW)** Myoelectric multi-grip vs no prosthetic use • 1 cross-sectional survey (Resnik et al 2020c) reported QuickDASH mean (±SD) for 40 participants **(VERY LOW)**: • *No statistically significant difference* for the self-reported performance of two-handed tasks using a myoelectric multi-grip prosthetic vs no prosthetic use (lift and carry bulky objects: 2.8±1.3 vs 2.7±1.1, p=0.67; spread peanut butter: 3.1±1.4 vs 3.3±1.3, p=0.60; do housework: 2.5±1.1 vs 2.8±1.2, p=0.12). • *Statistically significantly better* self-reported performance of one-handed tasks using a myoelectric multi-grip prosthetic vs no prosthetic use (i.e. using the remaining residual limb) (pick up small objects: 3.5±1.1 vs 4.5±1.1, p=0.0008; grasp rounded objects (2.6±1.2 vs 4.1±1.2, p<0.0001). **There was very low certainty evidence of better functional outcomes using a myoelectric multi-grip prosthetic from one longitudinal crossover study in which participants were tested using a multi-grip and single grip prosthetic. However, the cross-sectional studies and survey generally reported no statistically significant differences in functional outcome measures between upper limb amputees who use a multi-grip or single grip prosthetic. For the 1 cross-sectional study showing a statistically significant difference for 2 measures, the better mean scores were for users of the single grip prosthetics.** **There was very low certainty evidence of better functional outcomes for one-handed tasks using a myoelectric multi-grip prosthetic compared to no prosthetic use (i.e. using the remaining residual limb). There was no statistically significant difference in the performance of two-handed tasks with or without a myoelectric multi-grip prosthetic.**
Activities of daily living **Certainty of evidence:** Very low	Activities of daily living (ADLs) are critical outcomes to patients as they facilitate enablement and independence, allowing individuals to function in education, work, home and recreational settings. They encompass patients' individual rehabilitation goals and facilitate inclusion and participation. ADL measures reported in the included papers were the Activities Measure for Upper Limb Amputation (AM-ULA), the Brief AM-ULA (BAM-ULA) and the Timed Measure of Activity Performance (T-MAP)[b]. Papers also reported whether patients required help with daily activities. In total 2 papers provided evidence relating to ADL, including 2 different comparisons: • One cross-sectional study compared outcomes for users of myoelectric multi-grip prosthetics (n=25), myoelectric single grip prosthetics (n=27) or

	body powered single grip prosthetics (n=75). Outcomes were reported separately for unilateral TR and TH amputees (Resnik et al 2020b). • One cross-sectional survey compared outcomes for unilateral upper limb amputees using a myoelectric multi-grip prosthetic (n=40) or a body powered single grip prosthetic (n=325) (Resnik et al 2020c). Myoelectric multi-grip vs myoelectric single grip vs body powered single grip: • One cross-sectional study (Resnik et al 2020b) reported comparisons across 3 prosthetic types (myoelectric multi-grip (n=25), myoelectric single grip (n=27), body powered single grip (n=75)). **(VERY LOW)** • There was *no statistically significant difference* across the 3 prosthetic types for unilateral TR or TH amputees for AM-ULA (mean (SD) TR: myoelectric multi-grip (n=18) 16.4 (6.5), myoelectric single grip (n=12) 14.9 (7.7), body powered single grip (n=45) 14.9 (5.3), p=0.68); TH myoelectric multi-grip (n=5) 11.9 (1.8), myoelectric single grip (n=9) 9.4 (4.2), body powered single grip (n=18) 12.3 (6.2), p=0.23). • On the BAM-ULA there was a *statistically significant difference* across the 3 prosthetic types for unilateral TR amputees (mean (SD) myoelectric multi-grip (n=18) 8.0 (1.6), myoelectric single grip (n=12) 9.2 (1.0), body powered single grip (n=45) 6.6 (2.1), p=0.002), but *no statistically significant difference* for TH amputees (mean (SD) myoelectric multi-grip (n=5) 3.5 (0.7), myoelectric single grip (n=9) 4.0 (not stated), body powered single grip (n=18) 4.5 (3.4), p=0.83). • There was *no statistically significant difference* across the 3 prosthetic types for unilateral TR or TH amputees for T-MAP (mean (SD) TR: myoelectric multi-grip (n=18) 3.9 (0.9), myoelectric single grip (n=12) 3.9 (0.6), body powered single grip (n=45) 5.0 (1.8), p=0.081); TH: myoelectric multi-grip (n=5) 7.4 (3.0), myoelectric single grip (n=9) 4.9 (1.2), body powered single grip (n=18) 4.6 (1.7), p=0.18). • There was *no statistically significant difference* in the percentage of participants needing help with daily activities across the 3 prosthetic types for unilateral TR or TH amputees (TR: myoelectric multi-grip (n=18) 16.7%, myoelectric single grip (n=12) 37.5%, body powered single grip (n=45) 21.2%, p=0.57); TH: myoelectric multi-grip (n=5) 20%, myoelectric single grip (n=9) 28.6%, body powered single grip (n=18) 25%, p=1.0). Myoelectric multi-grip vs body powered single grip • 1 cross-sectional survey (Resnik et al 2020c) reported *no statistically significant difference* in help needed with daily activities between myoelectric multi-grip prosthetic users (n=40) and body powered single grip prosthetic users (n=325) in multi-variate logistic modelling (OR 1.75 (95%CI 0.81 to 3.79) (p=0.1557). **(VERY LOW)** **This study and survey generally reported very low certainty evidence of no statistically significant differences in ADL for upper limb amputees. One study compared outcomes for unilateral upper limb amputees across three prosthetic types: myoelectric multi-grip, myoelectric single grip and body powered single grip prosthetics but did not report pairwise comparisons. For the one measure that showed a statistically significant difference, the best mean score was for the myoelectric single grip prosthetic. A direct (pairwise) comparison was only reported for one outcome in one survey and did not report any evidence of benefit of the myoelectric multi-grip prosthetic compared to a body powered single grip prosthetic in terms of help needed with daily activities**.

Quality of life **Certainty of evidence:** Very low	Quality of life is a critical outcome to patients as it provides an indication of an individual's general health and self-perceived well-being and their ability to participate in activities of daily living. A prosthetic aims to promote independence and enablement in daily life. Quality of life measures reported in the included papers were the EURO Quality of Life Questionnaire 5 Dimensions (EURO-QoL EQ-5D), the Hospital Anxiety and Depression Scale (HADS) and the Veterans 12-item Health Survey (VR-12)[c]. In total 3 papers provided evidence relating to quality of life, including 3 comparisons: • One longitudinal crossover study compared outcomes for 6 unilateral transradial amputees using a myoelectric multi-grip prosthetic after 6 months utilisation with outcomes using their existing myoelectric single grip prosthetic at baseline (Luchetti et al 2015). • One cross-sectional study compared outcomes for users of myoelectric multi-grip prosthetics (n=25), myoelectric single grip prosthetics (n=27) or body powered single grip prosthetics (n=75). Outcomes were reported separately for TR and TH amputees (Resnik et al 2020b). • One cross-sectional survey compared outcomes for unilateral upper limb amputees using a myoelectric multi-grip prosthetic (n=40) or a body powered single grip prosthetic (n=325) (Resnik et al 2020c). Myoelectric multi-grip vs myoelectric single grip: • 1 longitudinal crossover study (Luchetti et al 2015, n=6) reported *no statistically significant difference* between a myoelectric multi-grip prosthetic at 6 months vs a myoelectric single grip prosthetic at baseline for 2 quality of life measures: EUROQoL EQ-5D summary index (median (range) 0.858 (0.539 to 0.919) vs 0.901 (0.796 to 0.919), p >0.05); EUROQoL EQ-5D visual analogue scale (90.0 (70 to 100) vs 87.5 (70 to 100), p>0.05; HADS anxiety (2.0 (0 to 9) vs 2.0 (0 to 7), p>0.05); HADS depression (3.5 (0 to 6) vs 2.5 (1 to 5), p>0.05). **(VERY LOW)** Myoelectric multi-grip vs myoelectric single grip vs body powered single grip: • One cross-sectional study (Resnik et al 2020b) reported comparisons across 3 prosthetic types (myoelectric multi-grip (n=25), myoelectric single grip (n=27), body powered single grip (n=75)). Results were reported separately for unilateral TR and TH amputees. **(VERY LOW)**: • There was *no statistically significant difference* across the 3 prosthetic types in the VR-12 mental component summary (mean (SD) TR: myoelectric multi-grip (n=18) 52.4 (11.5), myoelectric single grip (n=12) 46.3 (12.8), body powered single grip (n=45) 53.5 (10.1), p=0.085); TH: myoelectric multi-grip (n=5) 52.9 (9.4), myoelectric single grip (n=9) 50.6 (14.6), body powered single grip (n=18) 50.4 (13.1), p=0.98). • There was *no statistically significant difference* across the 3 prosthetic types in the VR-12 physical component summary (mean (SD) TR: myoelectric multi-grip (n=18) 41.1 (8.2), myoelectric single grip (n=12) 43.2 (6.9), body powered single grip (n=45) 37.5 (8.9), p=0.085); TH: myoelectric multi-grip (n=5) 44.0 (8.1), myoelectric single grip (n=9) 41.9 (5.6), body powered single grip (n=18) 34.7 (13.2), p=0.17). Myoelectric multi-grip vs body powered single grip • 1 cross-sectional survey (Resnik et al 2020c) reported *no statistically significant difference* in VR-12 mental or physical component summary

	between myoelectric multi-grip prosthetic users (n=40) and body powered single grip prosthetic users (n=325) in multi-variate linear regression modelling (VR-12 mental β 2.59 (95%CI -2.14 to 7.32) (p=0.2825); VR-12 physical β -0.97 (95%CI -3.99 to 2.05) (p=0.5295)). **(VERY LOW)** **One study and one survey reported very low certainty evidence of no statistically significant difference in quality of life in direct (pairwise) comparisons between upper limb amputees using myoelectric multi-grip and myoelectric single grip or body powered single grip prosthetics respectively. One study compared outcomes for unilateral upper limb amputees across three prosthetic types: myoelectric multi-grip, myoelectric single grip and body powered single grip and reported no statistically significant difference between the 3 prosthetic types but did not report pairwise comparisons with myoelectric multi-grip prosthetics.**
Important outcomes	
Prosthetic abandonment **Certainty of evidence:** Very low	Prosthetic abandonment is an important outcome to patients as it may reflect issues with functional aspects of the prosthetic. Prosthetic abandonment is seen more frequently with proximal amputations. In total, one longitudinal survey provided data relating to prosthetic abandonment in people with upper limb amputation using different prosthetics. Resnik et al 2020a stated the percentage of respondents who reported using a different prosthetic in the 12-month follow-up survey than they had been using in the baseline survey. This was reported for different baseline prosthetic devices: • Myoelectric multi-grip (n=33): 58% • Body powered single grip (n=232): 20% • Myoelectric single grip (powered hook) (n=14): 43% • Myoelectric single grip (Sensor speed) (n=10): 40% • Myoelectric single grip (Greifer) (n=6): 67% No statistical tests reported. **(VERY LOW)** **This survey provides very low certainty evidence about the percentage of prosthetic users who had changed device in a 12-month period. However, it does not provide any statistical evidence that examines prosthetic abandonment for myoelectric control multi-grip prosthetics compared to standard upper limb prosthetics.**
Patient satisfaction and prosthetic acceptability **Certainty of evidence:** Very low	Patient satisfaction and prosthetic acceptability are important outcomes as this promotes inclusion and can assist with the psychological adaptation to limb difference. Acceptability can promote prosthetic use. Measures reported in the included papers were the Trinity Amputation and Prosthesis Experience Scales Satisfaction Scale (TAPES-SAT), the Amputee Body Image Scale (ABIS) and the Orthotics and Prosthetics User Survey Client Satisfaction with Devices Scale (OPUS-CSD)[d]. In total, 3 papers provided evidence relating to patient satisfaction and prosthetic acceptability, including 3 comparisons: • One longitudinal crossover study compared outcomes for 6 unilateral transradial amputees using a myoelectric multi-grip prosthetic after 6 months utilisation with outcomes using their existing myoelectric single grip prosthetic at baseline (Luchetti et al 2015).

	• One cross-sectional study compared outcomes for myoelectric multi-grip prosthetics users (n=25), myoelectric single grip prosthetics users (n=27) or body powered single grip prosthetics users (n=75). Outcomes were reported separately for unilateral TR and TH amputees (Resnik et al 2020b). • One cross-sectional survey compared outcomes for unilateral upper limb amputees using myoelectric multi-grip prosthetics (n=40) vs myoelectric single grip prosthetics (n=30). Outcomes were also compared for users of myoelectric multi-grip prosthetics and any (myoelectric or body powered) single grip prosthetic (n=364) (Resnik et al 2020d). Myoelectric multi-grip vs myoelectric single grip: • 1 longitudinal crossover study (Luchetti et al 2015, n=6) reported *no statistically significant difference* between a myoelectric multi-grip prosthetic at 6 months vs a myoelectric single grip prosthetic at baseline for 2 patient satisfaction measures: TAPES-SAT (median (range) 43 (27 to 46) vs 43 (35 to 45), p >0.05); ABIS (median (range) 36.0 (33 to 50) vs 34.0 (33 to 48), p>0.05). **(VERY LOW)** • 1 cross-sectional survey (Resnik et al 2020d) reported *no statistically significant difference* between myoelectric multi-grip prosthetic users (n=40) and myoelectric single grip prosthetic users (n=30) in bi-variate linear regression modelling for 2 measures: TAPES-SAT β 0.11 (95%CI not reported) (p=0.4812); OPUS-CSD β -0.57 (95%CI not reported) (p=0.9023). **(VERY LOW)** Myoelectric multi-grip vs myoelectric single grip vs body powered single grip: • One cross-sectional study (Resnik et al 2020b) reported comparisons across 3 prosthetic types (myoelectric multi-grip (n=25), myoelectric single grip (n=27), body powered single grip (n=75)). Results were reported separately for unilateral TR and TH amputees. **(VERY LOW)**: • There was *no statistically significant difference* across the 3 prosthetic types in TAPES-SAT (mean (SD) TR: myoelectric multi-grip (n=18) 3.8 (0.7), myoelectric single grip (n=12) 3.5 (0.7), body powered single grip (n=45) 4.0 (0.7), p=0.051); TH: myoelectric multi-grip (n=5) 3.7 (0.5), myoelectric single grip (n=9) 3.5 (0.5), body powered single grip (n=18) 3.7 (0.9), p=0.64). Myoelectric multi-grip vs any single grip (myoelectric or body powered): • 1 cross-sectional survey (Resnik et al 2020d) reported *no statistically significant difference* between myoelectric multi-grip prosthetic users (n=40) and single grip prosthetic users (n=364) in bi-variate linear regression modelling for 2 measures: TAPES-SAT β -0.07 (95%CI not reported) (p=0.5286); OPUS-CSD β 1.58 (95%CI not reported) (p=0.6043). (**VERY LOW)** **One study and one survey reported very low certainty evidence of no statistically significant difference in patient satisfaction and prosthetic acceptability in direct (pairwise) comparisons between upper limb amputees using myoelectric multi-grip and myoelectric single grip or any single grip prosthetics respectively. One study compared outcomes for unilateral upper limb amputees across three prosthetic types: myoelectric multi-grip, myoelectric single grip and body powered single grip and reported no statistically significant difference between the 3 prosthetic types but did not report pairwise comparisons with myoelectric multi-grip prosthetics.**

Device durability **Certainty of evidence:** Very low	Device durability is an important outcome for patients as it can impact on functional use. It also reflects service delivery needs including maintenance and cost. In total, one longitudinal crossover study provided non-comparative evidence relating to device durability in people with unilateral upper limb amputation using a myoelectric control multi-grip prosthetic. Luchetti et al 2015 reported that 4 of 6 participants (66.7%) experienced at least one temporary failure of the myoelectric control multi-grip prosthetic over the 6-month study period. No further details were reported. **(VERY LOW)** **There is very low certainty evidence about the proportion of patients who experienced at least one temporary device failure during one study. However, this study does not provide any evidence about the durability of myoelectric control multi-grip prosthetics compared to standard upper limb prosthetics.**
Frequency of replacement and/or re-fitting **Certainty of evidence:** Not applicable	Frequency of replacement and/or re-fitting is an important outcome to patients as it impacts on user comfort and functional use. **No evidence was identified for this outcome.**
Safety	
Adverse events **Certainty of evidence:** Not applicable	Safety is an important outcome to patients to ensure prosthetic devices do not cause issues in the residual limb. Users may experience over-use injuries and/or pain in remaining muscle groups to operate the device. **No evidence was identified for this outcome.**
Abbreviations: ABIS: Amputee Body Image Scale, ADL: activities of daily living, AM-ULA: Activities Measure for Upper Limb Amputation, ARAT: Action Research Arm Test, BAM-ULA: Brief Activities Measure for Upper Limb Amputation, BBT: Box and Block Test, CI: confidence interval, CPRT: Clothespin-relocation test, DASH: Disabilities of the Arm, Shoulder and Hand, EURO-QoL EQ-5D: EURO Quality of Life Questionnaire 5 Dimensions, HADS: Hospital Anxiety and Depression Scale, MMDT: Minnesota Manual Dexterity Test, OPUS-CSD: Orthotics and Prosthetics User Survey Client Satisfaction with Devices Scale; OPUS-UEFS: Orthotics and Prosthetics User Survey-Upper Extremity Functional Status, QuickDASH: Quick Disabilities of the Arm, Shoulder and Hand, SD: standard deviation, SHAP: Southampton Hand Assessment Procedure, TAPES-SAT: Trinity Amputation and Prosthesis Experience Scales Satisfaction Scale, TH: transhumeral, T-MAP: Timed Measure of Activity Performance, TR: transradial, VR-12: Veterans 12-item Health Survey	
a Functional outcome measures: • BBT assesses arm/hand dexterity through the number of wooden blocks moved from one area to another in 1 minute with higher scores indicating higher functionality • MMDT assesses arm/hand dexterity through the time taken (in seconds) to place 60 round pegs into holes with lower scores indicating higher functionality • CPRT assess functionality through the time taken to transfer 4 clothespins of various strengths from a horizontal bar to a vertical one. Lower scores indicate higher functionality • The Nine Hole Peg Test assesses arm/hand dexterity through the time taken to accurately place and remove 9 pegs into and from a pegboard. Mean score calculated as items per second. Higher scores indicate higher functionality	

- SHAP assesses hand dexterity in 12 abstract object tasks and 14 activities of daily living. Time in seconds to complete each task is inputted into a scoring chart that calculates an overall index of functionality with higher scores indicating higher functionality
- ARAT assesses upper limb motor function through 4 sections with different tasks with a maximum score of 57 points. Higher scores indicate higher functionality
- DASH assesses upper limb physical function in activities of daily living using a 30-item self-report questionnaire (DASH is listed as a functional outcome measure in the PICO). Scores range from 0 (no disability) to 100 (most severe disability) with lower scores indicating higher functionality. The PICO states that the minimally clinical important difference is an improvement in DASH score of >14
- QuickDASH is a self-report questionnaire assessing difficulty performing activities, amount of limitation, extent of interference with activities and extent of arm, shoulder and hand pain and tingling. Scores range from 1 (very easy) to 5 (cannot do at all) with lower scores indicating higher functionality
- OPUS-UEFS assesses upper limb physical function in activities of daily living using a 23-item self-report questionnaire. Scores range from 0 to 100 with lower scores indicating higher functionality

b ADL measures:

- AM-ULA is an assessment of activity performance for 18 everyday tasks. Each task is rated on task completion, speed, movement, quality, skilfulness of prosthetic use and independence. Total score is the average score x 10 with higher scores indicating better performance
- BAM-ULA is an assessment of ability to complete 10 everyday tasks. Total score is the number of completed activities with higher scores indicating better performance
- T-map is an assessment of time taken to complete 5 everyday activities. Lower scores indicate better performance

c Quality of life measures:

- EuroQoL EQ-5D assesses self-reported health-related quality of life for 5 items (mobility, self-care, usual activities, pain and discomfort, and anxiety and depression). A summary index scored from 0 to 1 and a visual analogue scale from 0 to 100 were used to rate perceived health status. Higher scores indicate higher quality of life
- HADS assesses anxiety and depression using a 14-item self-report questionnaire. Scores range from 0 to 21 with lower scores indicating less anxiety or depression. The authors gave a cut-off of ≥ 8 for considering participants to be anxious or depressed
- The VR-12 is a 12-item self-report questionnaire assessing health-related quality of life with a mental and physical component summary. Scores range from 1 to 100 with higher scores indicating higher quality of life

d Patient satisfaction measures:

- TAPES-SAT is a 10-item self-report questionnaire assessing prosthetic satisfaction through colour, shape, noise, appearance, weight, usefulness, reliability, fit, comfort and overall satisfaction. Items are rated on a 5-point scale from 1 (very dissatisfied) to 5 (very satisfied) with higher scores indicating higher satisfaction
- ABIS assesses body image concerns using a 20-item self-report questionnaire. Scores range from 20 to 100 with lower scores indicating fewer concerns
- A modified version of the OPUS-CSD self-report questionnaire was used with 8-items assessing prosthetic satisfaction through fit, weight, comfort, donning ease, appearance, durability, skin irritation and pain. Items are rated on a 4-point scale from 1 (strongly agree) to 4 (strongly disagree) with lower scores indicating higher satisfaction

From the evidence selected, are there any subgroups of patients that may benefit from the myoelectric control multi-grip upper limb prosthetic more than the wider population of interest?

Outcome	Evidence statement
Subgroups	**No evidence was identified regarding any subgroups of patients that would benefit more from treatment with a myoelectric multi-grip prosthetic.** Four of the six included papers only included participants with unilateral amputation (Luchetti et al 2015, Resnik et al 2020c, Resnik et al 2020d, Salminger et al 2019). The remaining two papers included both unilateral and bilateral amputees (Resnik et al 2020a, Resnik et al 2020b). Resnik et al 2020a pooled the results of unilateral and bilateral amputees for the only outcome that they reported by type of prosthetic. Resnik et al 2020b reported three functional outcome measures separately for all participants (both unilateral and bilateral amputees) and for unilateral amputees only. Four papers included participants with different levels of amputation (Resnik et al 2020a, Resnik et al 2020b, Resnik et al 2020c, Resnik et al 2020d), but only one paper (Resnik et al 2020b) reported outcomes separately for transradial and transhumeral amputees. However, although some outcomes were reported separately in some studies, the pattern of results appeared similar for the different populations. No statistical tests of difference in effect between unilateral and bilateral amputees or between transradial or transhumeral amputees were reported.

In adults and children with either congenital upper limb deficiency or acquired upper limb amputation, what is the cost effectiveness of the myoelectric control multi-grip upper limb prosthetic compared with standard upper limb prosthetic use or no prosthetic use?

Outcome	Evidence statement
Cost effectiveness	No evidence was identified for cost effectiveness.

6. Discussion

This review considered the evidence for the clinical effectiveness and safety of myoelectric control multi-grip upper limb prosthetics compared to standard upper limb prosthetics or no prosthetic use in patients with congenital upper limb deficiency or acquired upper limb amputation. Myoelectric control multi-grip prosthetics that are commercially available in the UK were eligible for inclusion. The critical outcomes of interest were functional outcome measures, activities of daily living and quality of life. Important outcomes were prosthetic abandonment, patient satisfaction and prosthetic acceptability, device durability and frequency of replacement and/or re-fitting.

Evidence was available from six papers from which outcomes by type of prosthetic could be extracted. Together, these papers provided data comparing myoelectric multi-grip prosthetics to single grip prosthetics or no prosthetic use. Three papers reported the results of studies and three papers reported the results of two surveys. All were at high or very high risk of bias. Certainty of the evidence for both critical and important outcomes was very low when assessed using modified GRADE. No evidence was identified for the important outcomes of frequency of replacement and/or re-fitting and safety. No evidence was identified on cost effectiveness.

The three papers reporting studies comprised one longitudinal crossover study (Luchetti et al 2015) and two cross-sectional studies (Salminger et al 2019, Resnik et al 2020b).

Luchetti et al 2015 compared outcomes for six unilateral transradial amputees using their existing myoelectric single grip prosthetic at baseline with a myoelectric multi-grip prosthetic used for three months (functional assessment) and used for six months (psychosocial assessment). A statistically significant benefit with the myoelectric multi-grip prosthetic was reported for various objective functional outcome measures after three months. For one of these measures, the Box and Block Test, the study authors stated that four of the six participants showed an improvement with the multi-grip prosthetic that was larger than the ‘minimum detectable change’. The reporting of two self-reported functional measures was less clear although there appears to have been no difference between the different prosthetics for the DASH scale. Five of the six participants were reported to demonstrate an easier execution of activities of daily living for the OPUS-UEFS scale, but little further detail was reported. There was no statistically significant difference between self-reported quality of life or patient satisfaction and prosthetic acceptability outcomes assessed with the myoelectric single grip prosthetic at baseline and after six months use of the myoelectric multi-grip prosthetic. The study authors noted that participants showed positive quality of life and patient satisfaction and prosthetic acceptability scores at baseline with their single grip prosthetic and that scores were also positive with the multi-grip prosthetic. The study authors reported that four of the six participants experienced at least one temporary device failure with the myoelectric multi-grip prosthetic over the six-month study period. In Luchetti et al 2015 there was no randomisation of the order in which participants were tested using the different prosthetics. This introduces a potential risk of bias in the possibility of a practice effect as all participants had gained experience of the assessments using the myoelectric single grip prosthetic before completing the assessments with the myoelectric multi-grip prosthetic.

The two cross-sectional studies did not demonstrate a benefit for participants who use a myoelectric multi-grip prosthetic when compared to participants who use a single grip prosthetic. In Salminger et al 2019 there was no statistically significant difference for four objective functional outcome measures between unilateral below elbow amputees using a myoelectric multi-grip (n=5) or a myoelectric single grip (n=8) prosthetic. Resnik et al (2020b) reported objective and self-reported functional outcome measures, self-reported activities of daily living, self-reported quality of life and self-reported patient satisfaction. Both unilateral and bilateral amputees were included in the reporting of some functional outcomes, but other outcomes were reported for unilateral amputees only. All outcomes were reported separately for transradial and transhumeral amputees in this study. Although some statistically significant results were reported, these were for comparisons across three prosthetic types (myoelectric multi-grip, myoelectric single grip and body powered single grip) and no direct pairwise comparisons were reported between myoelectric multi-grip prosthetics vs other prosthetic types. Where the comparative results (p values) reported (across the three prosthetic types) were statistically significant, the most beneficial mean scores were for single grip prosthetics. The authors controlled for multiple comparisons in the analysis.

In both the Salminger et al 2019 and Resnik et al 2020b studies, participants were assessed using their own existing prosthetic. User need may determine choice of prosthetic and the authors did not account for potential confounding factors, so the comparisons between types of prosthetic should be interpreted with caution.

The three papers reporting surveys comprised two papers reporting outcomes from the same cross-sectional survey of veterans with unilateral upper limb amputation (Resnik et al 2020c, Resnik et al 2020d) and one longitudinal survey of veterans with upper limb amputation conducted 12 months apart (Resnik et al 2020a).

Resnik et al 2020c and Resnik et al 2020d did not report any statistically significant differences between users of multi-grip and single grip prosthetics for functional outcome measures, activities of daily living, quality of life or patient satisfaction (all self-reported) with different comparisons reported for different outcomes, including myoelectric multi-grip prosthetics (n=40): vs myoelectric single grip (n=30); vs body powered single grip (n=325) and vs any single grip (n=364). Resnik et al 2020c also reported one functional outcome measure as a comparison between myoelectric multi-grip prosthetic users (n=40) wearing their prosthetic vs not using a prosthetic. There was no significant difference for two-handed tasks with and without the myoelectric multi-grip prosthetic. Significantly better functional outcomes were observed for one-handed tasks for participants wearing their multi-grip prosthetic compared to using the remaining residual limb without a prosthetic. However, the usefulness of this comparison in understanding the effectiveness of myoelectric multi-grip prosthetics in a real-world setting is questionable.

The sixth included paper was a longitudinal survey of veterans with upper limb amputation conducted 12 months apart (Resnik et al 2020a), which reported data on prosthetic abandonment for users of myoelectric multi-grip (n=33), myoelectric single grip (n=30) or body powered single grip (n=323) prosthetics. The authors did not collect data on why prosthetics were abandoned or consider any potential confounding factors. Data on the prosthetic types used at baseline and follow-up was only provided graphically without numerical values to clarify which type of prosthetic participants were changing to.

In all three of these surveys, participants were assessed using their own existing prosthetic and all data on prosthetic type and outcomes were self-reported. Response rates for the surveys were 72% (Resnik et al 2020a) and 48% (Resnik et al 2020c and Resnik et al 2020d). Potential risk of bias limiting the interpretation of the results is introduced by the self-reported data, the fact that user need may determine choice of prosthetic and the fact that people who chose to participate in the surveys may not be representative of the wider population targeted by the surveys. The comparisons between the types of prosthetic should therefore be interpreted with caution.

Specific details about the populations of all the individual studies and surveys was lacking (e.g. demographics, occupation, training and support received). The population information that was available was not reported in a way that could be used to interpret the results, for example, in relation to occupational or other subgroups.

Many of the scales reported by the included papers cover concepts that could relate to more than one of the critical and important outcomes stated in the PICO. Examples of relevant scales for each of the outcomes of interest were provided in the PICO and these have been used to determine which outcome category to place each scale in. For example, DASH is listed as an example of a functional outcome measure in the PICO therefore results for the DASH and QuickDASH scale have been included under this outcome heading. Several of the outcome measures reported by studies also assess more than one domain or type of skill/ability which limits the interpretation of the results.

As multiple measures were available for several of the outcomes, data for measures that provided a comparison, with a measure of statistical significance, between a myoelectric multi-grip prosthetic and another type of prosthetic or no prosthetic use were extracted. We did not extract data comparing two comparison prosthetics (e.g. body powered single grip devices compared to cosmetic devices). Measures reporting a composite or total score were also prioritised[30]. For example, if results were available for multiple different functional outcome measures, we extracted data for the measures that included a composite or total score but not the measures reporting separate scores for individual tasks or questions within a measure. An exception was made in extracting the non-composite QuickDASH tasks scores for a comparison of myoelectric multi-grip users with their prosthetic on and with no prosthetic use. This was because the data included a statistical test of the intervention vs a comparator and these were the only data available for this comparison.

No studies reported data directly comparing myoelectric control multi-grip prosthetics to non-myoelectric control multi-grip prosthetics, to cosmetic or terminal device prosthetics or to amputees who do not use a prosthetic.

Although several papers included participants from subgroups of interest, only one paper (Resnik et al 2020b) reported outcomes separately for different subgroups. However, no conclusions can be drawn about whether one subgroup of patients would benefit more as no statistical tests of difference in effect between unilateral and bilateral amputees or between transradial or transhumeral amputees were reported.

In all the included papers, outcomes were assessed at a single measurement point or a single timepoint providing a snapshot of functional ability or self-reported quality of life and satisfaction at that time. Caution should be exercised in drawing wider, longer-term conclusions.

Most participants were male adults and, in four papers, participants were all or mostly US veterans. Study dates were not always stated. The multi-grip and single grip prosthetics used by participants varied with some papers reporting results for a specific prosthetic model and others pooling results by type of grip. One of the papers included one device, the LUKE arm, among the four models of myoelectric multi-grip prosthetics listed as being used by participants. This prosthetic device is not commercially available in the UK and the

[30] The PICO stated that composite and/or total scores from tools should be included

number of study participants using this prosthetic was not stated. The generalisability of the results is not clear.

7. Conclusion

Very low certainty evidence for an additional benefit for a myoelectric control multi-grip prosthetic compared to myoelectric single grip prosthetics was found for one critical outcome (functional outcome measures) in one longitudinal crossover study where the same participants were tested using different prosthetics. However, in this study there was no statistically significant difference between prosthetics in other critical (quality of life) and important (patient satisfaction and prosthetic acceptability) outcomes. Four cross-sectional studies or surveys comparing critical and important outcomes in users of different prosthetics did not identify a benefit for myoelectric control multi-grip prosthetics compared to single grip prosthetics (very low certainty). In the one cross-sectional study reporting a statistically significant difference for two functional outcome measures and one activities of daily living measure, the better mean scores were for users of single grip prosthetics. One survey provided very low certainty evidence for a benefit for a myoelectric multi-grip prosthetic compared to no prosthetic use for one-handed tasks using the remaining residual limb. No statistical comparison between prosthetic type was available for the important outcome of prosthetic abandonment and no comparative evidence was available for the important outcome of device durability. No evidence was identified for the important outcomes of frequency of replacement and/or re-fitting or safety.

No evidence was identified regarding any subgroups of patients that would benefit more from treatment with a myoelectric multi-grip prosthetic. No evidence was identified on cost effectiveness.

Further research, preferably involving the randomisation of participants to different groups, is required to further understand the clinical effectiveness, safety and cost effectiveness of myoelectric multi-grip prosthetics compared to standard prosthetics.

Appendix A PICO Document

The review questions for this evidence review are:

1. In adults and children with either congenital upper limb deficiency or acquired upper limb amputation, what is the clinical effectiveness of the myoelectric control multi-grip upper limb prosthetic compared with standard[31] upper limb prosthetics or no prosthetic use?

2. In adults and children with either congenital upper limb deficiency or acquired upper limb amputation, what is the safety of the myoelectric control multi-grip upper limb prosthetic compared with standard upper limb prosthetic use or no prosthetic use?

3. In adults and children with either congenital upper limb deficiency or acquired upper limb amputation, what is the cost effectiveness of the myoelectric control multi-grip upper limb prosthetic compared with standard upper limb prosthetic use or no prosthetic use?

4. From the evidence selected, are there any subgroups of patients that may benefit from the myoelectric control multi-grip upper limb prosthetic more than the wider population of interest?

P-Population and Indication	Adults and children with unilateral or bilateral upper limb loss as the result of either acquired amputation or congenital absence (congenital deficiency) Subgroups of interest: • Proximal (above elbow) vs distal (below elbow) amputation levels • Child (<18years) vs adult (> 18 years) • Unilateral (one-sided) vs bilateral (both-sided) upper limb loss [Below elbow amputation could be defined as transradial, wrist disarticulation, transcarpal or partial hand and finger absence. Above elbow amputation could be defined as elbow disarticulation, transhumeral, shoulder disarticulation and forequarter amputation] [Patients with upper limb loss as a result of either an acquired amputation or congenital (birth) deficiency are routinely offered rehabilitation and enablement using a prosthetic, a device that emulates a missing body part. If limb deficiency occurs at the level of the joint it is called disarticulation (shoulder, elbow or wrist disarticulation). Amputation levels occurring between joints from proximal (closer to the body) to distal (further away from the body) are forequarter (above the shoulder); transhumeral (above the elbow); transradial (below the elbow) and transcarpal (distal to the wrist). Prosthetic choice is dependent on the amputation level, patient factors and importantly functional need.]
I-Intervention	Myoelectric control multi-grip upper limb prosthetics that are commercially available in UK settings including: • **Myoelectric control multi-grip hand devices**

[31] The term "standard" includes passive functional prosthetics, body powered single grip devices, terminal devices, myoelectric control single-grip devices and non-myoelectric control multi-grip devices. Hand, partial hand or digit prosthetics are included.

	Myoelectric control multi-grip partial hand and digit devices [Myoelectric control multi-grip prosthetics are powered by an external battery power source. The mechanism allows multiple grip patterns through multiple articulations in the prosthetic. They are controlled through coordinated patterns of muscular movement in the remaining limb. The thumb and digits can move independently from each other. The thumb might be manually operated or powered dependent on the device] [Brand names and manufacturers are: i-limb or i-digit (Ossur); Michelangelo or bebionic hand (Ottobock); commercially available 3D-printed devices heroarm (Openbionics)] [Other devices which are not commercially available in UK setting/only available in research trial settings should be excluded e.g. LUKE and DEKA hand/arm]
C-Comparator	Standard upper limb prosthetics without myoelectric control multi-grip function - Passive functional hand, partial hand or digit prosthetics (also known as cosmetic or aesthetic prosthetics) - Body powered single grip prosthetics. Including hand, partial hand, digits or body powered hook prosthetics. - Non-myoelectric control multi-grip prosthetics. Including hand, partial hand and digits. - Myoelectric control single grip prosthetics. Including hand or partial hand prosthetics - Terminal device prosthetics No prosthetic use [Passive functional prosthetics have no intrinsic active moving parts and are used for grasping tasks, such as supporting, stabilising, pushing or pulling. The digits are positioned but act in a passive shape. Single grip prosthetics have a limited range of motion and the digits or thumb are not independently controlled. Terminal device prosthetics can be designed for a specific activity e.g. playing a sport] [A non-myoelectric control multi-grip upper limb prosthetic has a mechanism which allows multiple grip patterns through multiple articulations in the prosthetic. It is controlled through muscular movement in the remaining limb/hand or finger and/or controlled by the opposite side. The thumb and digits may move independently from each other to allow more than a single grip pattern. The device is not powered by an external battery source (e.g. it is not a myoelectric device)]
O-Outcomes	<u>**Clinical Effectiveness**</u> MCIDs are not available except where stated. Expected timepoints for measurement outcomes include a period of user training and device utilisation e.g. after 6-12 weeks. <u>*Critical to decision-making:*</u> **Functional outcome measures:** Functional outcomes are critical to patients as they facilitate enablement, independence and active participation. Functional outcomes include not only physical tasks but emotional, psycho-social and societal interaction.

	Examples include but not limited to: a) Timed task completion. (This could be a timed repeatable test measure such as the “box and block test (a construct/destruct of a tower using wooden blocks) or the 9-hole peg test (placing 9 wooden pegs into holes and removing them)) b) Functional assessment using a tool (*e.g. but not limited to:* Disabilities of the Arm Shoulder and Hand (DASH)[32]; Southampton Hand Assessment Profile (SHAPS); Trinity Amputation and Prosthesis Experience Scales (TAPES); Assessment of Capacity for Myoelectric Control (ACMC); Canadian Occupational Performance Measure (COPM))[33] c) Subjective/self-reported assessment. (This could include self-reported questionnaires/survey methods by the user or multi-disciplinary team (MDT) professional *e.g. but not limited to*: Orthotics and Prosthetic User Survey (OPUS)). [Please include composite and/or total scores from tools] • **Activities of daily living:** Activities of daily living (ADLs) are critical outcomes to patients as they facilitate enablement and independence, allowing individuals to function in education, work, home and recreational settings. They encompass patient’s individual rehabilitation goals and facilitate inclusion and participation. Examples include but not limited to: a) Timed task completion (This could be a timed repeatable test measure such as dressing, meal preparation or a patient specific ADL goal) b) ADLs assessment using a tool (*e.g. but not limited to:* Barthel Index (BI) or Independence in Activities of Daily Living (ADL) or Functional Independence Measure (FIM) or Functional Assessment Measure (FAM)) c) Subjective/self-reported assessment (e.g. by the user or multi-disciplinary team (MDT) professional. This could include self-reported questionnaires/survey methods (e.g. Goal Attainment Score (GAS); user reported dependency on others) [Please include composite and/or total scores from tools] • **Quality of life:** Quality of life is a critical outcome to patients as it provides an indication of an individual’s general health and self-perceived well-being and their ability to participate in activities of daily living. A prosthetic aims to promote independence and enablement in daily life. Examples include but not limited to: a) Validated questionnaire (e.g. EuroQol EQ-5D, Hospital Anxiety and Depression Score (HADs) or other disease specific questionnaire) b) Subjective/self-reported user experiences (e.g. Socket Comfort Score)

[32]DASH score is a 30-item self-reported questionnaire in which the response options are presented as 5-point Likert scales. Scores range from 0 (no disability) to 100 (most severe disability). **MCID-Number of patients with an improvement in DASH score of > 14** (NHS England, Hand and Upper Limb Transplant Service Specifications, Section 4.2, Clinical outcome 112)

[33]COPM is a personalised, patient-centered instrument designed to identify occupational performance problems. The therapist calculates an average COPM performance score and satisfaction score. These typically range between 1 and 10, where 1 indicates poor performance and low satisfaction, respectively, while 10 indicates very good performance and high satisfaction. **MCID-Number of patients with an improvement of COPM score > 1** (NHS England, Hand and Upper Limb Transplant Service Specifications, Section 4.2, Clinical outcome 113)

	Important to decision-making: • **Prosthetic abandonment** Prosthetic abandonment is an important outcome to patients as it may reflect issues with functional aspects of the prosthetic. Prosthetic abandonment is seen more frequently with proximal amputations. • **Patient satisfaction and prosthetic acceptability** Patient satisfaction and prosthetic acceptability are important outcomes as this promotes inclusion and can assist with the psychological adaption to limb difference. Acceptability can promote prosthetic use. [This considers satisfaction and acceptability in both functional task completion as well as psycho-social elements] Examples include but not limited to: a) Assessment using a tool (e.g. patient satisfaction scores) b) Subjective/self-reported assessment (e.g. cosmetic appearance of the prosthetic or likelihood to use in social/work situations or challenges/task avoidance with the prosthetic) • **Device durability** Device durability is an important outcome for patients as it can impact on functional use. It also reflects service delivery needs including maintenance and cost. [Device durability could include the repair frequency or days lost when device was not functional] • **Frequency of replacement and/or re-fitting** Frequency of replacement and/or re-fitting is an important outcome to patients as it impacts on user comfort and functional use. **Safety** Safety is an important outcome to patients to ensure prosthetic devices do not cause issues in the residual limb. Users may experience over-use injuries and/or pain in remaining muscle groups to operate the device. • *Adverse events* including but not limited to residual limb damage; over-use injuries in residual limb; residual limb infection. User discomfort and pain (assessed through a validated method (e.g. visual analogue scale (VAS)). **Cost effectiveness**
Inclusion criteria	
Study design	Systematic reviews, randomised controlled trials, controlled clinical trials, cohort studies. If no higher-level quality evidence is found, case series can be considered.
Language	English only
Patients	Human studies only

Age	All ages
Date limits	2005-2020
Exclusion criteria	
Publication type	Conference abstracts, non-systematic reviews, narrative reviews, commentaries, letters, editorials, pre-publication prints and guidelines
Study design	Case reports, resource utilisation studies

Appendix B Search strategy

Medline, Embase and the Cochrane Library were searched limiting the search to papers published in English language in the last 15 years. Conference abstracts, non-systematic reviews, narrative reviews, commentaries, letters, editorials, pre-publication prints, guidelines, case reports and resource utilisation studies were excluded.

One search was conducted for both myoelectric and non-myoelectric control prosthetics.

Search dates: 1 January 2005 to 11 November 2020

Medline search strategy 1:

1. Artificial Limbs/
2. (prosthes?s or prosthetic? or artificial limb? or bionic limb?).ti.
3. 1 or 2
4. exp Upper extremity/
5. ((upper adj2 (limb? or extremit*)) or finger? or hand? or forearm? or elbow? or arm? or shoulder?).ti.
6. (carpal or transcarpal or radial or transradial or humeral or glenohumeral or transhumeral).ti.
7. 4 or 5 or 6
8. 3 and 7
9. ((finger? or hand? or forearm? or elbow? or arm? or shoulder?) adj3 (prosthe* or artificial)).ti,ab,kw.
10. (upper adj2 (limb? or extremit*) adj3 (prosthe* or artificial)).ti,ab,kw.
11. ((carpal or transcarpal or radial or transradial or humeral or glenohumeral or transhumeral) adj3 prosthe*).ti,ab,kw.
12. 8 or 9 or 10 or 11
13. Electromyography/
14. (electromyogra* or electro myogra* or nonelectromyogra* or nonelectro myogra* or emg or myoelectric* or nonmyoelectric*).ti,ab,kw.
15. 13 or 14
16. 12 and 15
17. (prosthe* adj3 (bionic or pre-hensor? or prehensor? or body-powered or ((cable* or spring) adj3 (single or double or system? or powered)))).ti,ab,kw.
18. ((finger? or hand? or forearm? or elbow? or arm? or shoulder?) adj3 (pre-hensor? or prehensor? or body-powered or ((cable* or spring) adj3 (single or double or system? or powered)))).ti,ab,kw.
19. ((carpal or transcarpal or radial or transradial or humeral or glenohumeral or transhumeral) adj3 (pre-hensor? or prehensor? or body-powered or ((cable* or spring) adj3 (single or double or system? or powered)))).ti,ab,kw.
20. 18 or 19
21. 12 and 20
22. (multigrip? or multi-grip? or (multiple adj2 grip?)).ti,ab,kw.
23. (bebionic or michaelangelo hand or i-limb or i-digit? or COAPT Gen2 or "hero arm" or "luke arm" or "taska hand" or "zeus bionic limb" or "ability hand" or truelimb or "vincent evolution" or dexus prosthetic hand).ti,ab,kw.
24. (movolinoarm or ergoarm or ottobock or ottoboack or movoshoulder or electric wrist or myolino wrist or myowrist or moyrotronic or dynamic arm or electric elbow or utah arm or ergo electric pro or espire pro).ti,ab,kw.

25. (arm dynamics or naked prosthetics or griplock finger or pipdriver or mcpdriver or thumbdriver or x-hands or x-digit?).ti,ab,kw.
26. 16 or 21 or 22 or 23 or 24 or 25
27. exp animals/ not humans/
28. 26 not 27
29. (comment or editorial or letter or news or review).pt.
30. 28 not 29
31. limit 12 to ("systematic review" or "reviews (maximizes specificity)")
32. 30 or 31
33. limit 32 to (english language and yr="2005 -Current")

Medline search strategy 2[34]:

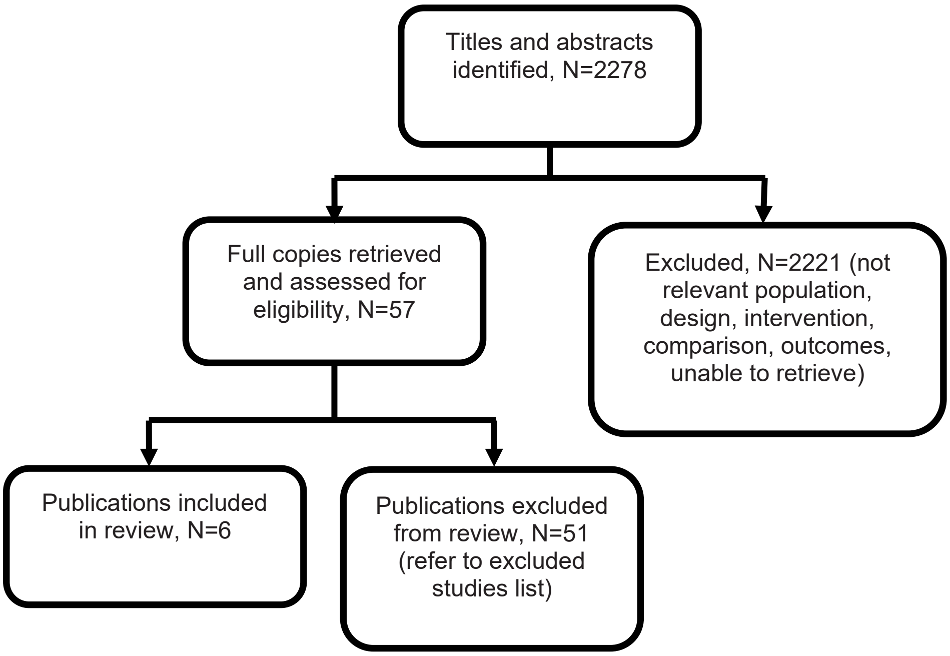
1	Artificial Limbs/
2	(prosthes?s or prosthetic? or artificial limb? or bionic limb?).ti.
3	1 or 2
4	exp Upper extremity/
5	((upper adj2 (limb? or extremit*)) or finger? or hand? or forearm? or elbow? or arm? or shoulder?).ti.
6	(carpal or transcarpal or radial or transradial or humeral or glenohumeral or transhumeral).ti.
7	4 or 5 or 6
8	3 and 7
9	((finger? or hand? or forearm? or elbow? or arm? or shoulder?) adj3 (prosthe* or artificial or bionic)).ti,ab,kw.
10	(upper adj2 (limb? or extremit*) adj3 (prosthe* or artificial or bionic)).ti,ab,kw.
11	((carpal or transcarpal or radial or transradial or humeral or glenohumeral or transhumeral) adj3 (prosthe* or artificial or bionic)).ti,ab,kw.
12	8 or 9 or 10 or 11
13	(bouwsema* or buckingham* or carey* or chadwell* or engdahl* or hargrove* or hermansson* or kulken* or lindner* or resnik* or romkema* or segil*).au.
14	12 and 13
15	limit 14 to (english language and yr="2005 -Current")

[34] This second, supplemental search for key authors (those with multiple publications) was conducted as an additional check for any potentially relevant papers

Appendix C Evidence selection

The combined literature searches for both myoelectric and non-myoelectric control multi-grip prosthetics identified 2,278 references. These were screened using their titles and abstracts and 57 references relating to either myoelectric control prosthetics or both types of prosthetics were obtained in full text and assessed for relevance. Of these, six references are included in the evidence summary. The 51 references excluded are listed in Appendix D. References relating to non-myoelectric control multi-grip prosthetics are considered in a separate review.

Figure 1- Study selection flow diagram



References submitted with Preliminary Policy Proposal

Reference	Paper Selection decision and rationale if excluded
Cloutier, A. Yang, J 2013, 'Control of hand prostheses-a literature review' American Society of Mechanical Engineers (ASME) 2013 International Design Engineering Technical Conferences and Computer Information in Engineering Conference, Portland, Oregon, USA, 4-7th August 2013.	Not included. Conference paper. Descriptive review of control schemes for prosthetic hands
S. Lura, D. Highsmith, M. Differences in myoelectric and body-powered upper-limb prostheses: Systematic literature review. Journal Rehabilitation Resource Development. 2015; 52(3): 247-62.	Not included. Broad review of studies about various prosthetics. No separate results for myoelectric multi-grip prosthetics. Any individual studies potentially in scope considered separately

Appendix D Excluded studies table

Study reference	Reason for exclusion
Abd Razak NA, Abu Osman NA, Gholizadeh H, Ali S. Biomechanics principle of elbow joint for transhumeral prostheses: comparison of normal hand, body-powered, myoelectric & air splint prostheses. Biomedical Engineering Online. 2014;13:134.	Not assessing outcomes specified in PICO
Biddiss E, Beaton D, Chau T. Consumer design priorities for upper limb prosthetics. Disability & Rehabilitation Assistive Technology. 2007;2(6):346-57.	Multiple device types. No separate results for multi-grip prosthetics
Bouwsema H, Kyberd PJ, Hill W, van der Sluis CK, Bongers RM. Determining skill level in myoelectric prosthesis use with multiple outcome measures. Journal of Rehabilitation Research & Development. 2012;49(9):1331-48.	Not assessing a multi-grip prosthetic
Bouwsema H, van der Sluis CK, Bongers RM. Movement characteristics of upper extremity prostheses during basic goal-directed tasks. Clinical Biomechanics. 2010;25(6):523-9.	Not assessing a multi-grip prosthetic
Buffart LM, Roebroeck ME, van Heijningen VG, Pesch-Batenburg JM, Stam HJ. Evaluation of arm and prosthetic functioning in children with a congenital transverse reduction deficiency of the upperlimb. Journal of Rehabilitation Medicine. 2007;39(5):379-86.	No results for multi-grip prosthetics
Burger H, Brezovar D, Vidmar G. A comparison of the University of New Brunswick Test of Prosthetic Function and the Assessment of Capacity for Myoelectric Control. European journal of physical & rehabilitation medicine. 2014;50(4):433-8.	No results for multi-grip prosthetics
Carey SL, Lura DJ, Highsmith MJ, Cp, Faaop. Differences in myoelectric and body-powered upper-limb prostheses: Systematic literature review. Journal of Rehabilitation Research & Development. 2015;52(3):247-62.	Broad review of studies about various prosthetics. No separate results for myoelectric multi-grip prosthetics. Any individual studies potentially in scope considered separately
Chadwell A, Kenney L, Granat M, Thies S, Galpin A, Head J. Upper limb activity of twenty myoelectric prosthesis users and twenty healthy anatomically intact adults. Scientific Data. 2019;6(1):199.	Not assessing a multi-grip prosthetic
Chadwell A, Kenney L, Granat MH, Thies S, Head J, Galpin A, et al. Upper limb activity in myoelectric prosthesis users is biased towards the intact limb and appears unrelated to goal-directed task performance. Scientific Reports. 2018;8(1):11084.	Not assessing a multi-grip prosthetic
Cho E, Chen R, Merhi LK, Xiao Z, Pousett B, Menon C. Force Myography to Control Robotic Upper Extremity Prostheses: A Feasibility Study. Frontiers in Bioengineering & Biotechnology. 2016;4:18.	Not assessing outcomes specified in PICO
Deijs M, Bongers RM, Ringeling-van Leusen ND, van der Sluis CK. Flexible and static wrist units in upper limb prosthesis users: functionality scores, user satisfaction and compensatory movements. Journal of Neuroengineering & Rehabilitation. 2016;13:26.	Not assessing a multi-grip prosthetic
Diment LE, Thompson MS, Bergmann JH. Three-dimensional printed upper-limb prostheses lack randomised controlled trials: A systematic review. Prosthetics & Orthotics International. 2018;42(1):7-13.	Review of type of studies about various 3D prosthetics. No separate results for myoelectric multi-grip prosthetics. Any individual studies potentially in scope considered separately
Dyson M, Dupan S, Jones H, Nazarpour K. Learning, Generalization, and Scalability of Abstract Myoelectric Control. IEEE Transactions on Neural Systems & Rehabilitation Engineering. 2020;28(7):1539-47.	Testing in laboratory setting without a period of device utilisation
Egermann M, Kasten P, Thomsen M. Myoelectric hand prostheses in very young children. International Orthopaedics. 2009;33(4):1101-5.	Not assessing a multi-grip prosthetic
Engdahl SM, Meehan SK, Gates DH. Differential experiences of embodiment between body-powered and myoelectric prosthesis users. Scientific reports. 2020;10(1):15471.	Participants used different types of prosthetic. No outcomes reported by type of prosthetic

Franzke AW, Kristoffersen MB, Bongers RM, Murgia A, Pobatschnig B, Unglaube F, et al. Users' and therapists' perceptions of myoelectric multi-function upper limb prostheses with conventional and pattern recognition control. PLoS ONE. 2019;14(8):e0220899.	Not assessing outcomes specified in PICO
Godfrey SB, Zhao KD, Theuer A, Catalano MG, Bianchi M, Breighner R, et al. The SoftHand Pro: Functional evaluation of a novel, flexible, and robust myoelectric prosthesis. PLoS ONE. 2018;13(10):e0205653.	Testing in laboratory setting without a period of device utilisation
Graczyk EL, Resnik L, Schiefer MA, Schmitt MS, Tyler DJ. Home Use of a Neural-connected Sensory Prosthesis Provides the Functional and Psychosocial Experience of Having a Hand Again. Scientific Reports. 2018;8(1):9866.	Not assessing a multi-grip prosthetic
Hargrove L, Miller L, Turner K, Kuiken T. Control within a virtual environment is correlated to functional outcomes when using a physical prosthesis. Journal of Neuroengineering & Rehabilitation. 2018;15(Suppl 1):60.	Not assessing a multi-grip prosthetic
Hargrove LJ, Miller LA, Turner K, Kuiken TA. Myoelectric Pattern Recognition Outperforms Direct Control for Transhumeral Amputees with Targeted Muscle Reinnervation: A Randomized Clinical Trial. Scientific Reports. 2017;7(1):13840.	Not assessing a multi-grip prosthetic
Hermansson LM, Bodin L, Eliasson AC. Intra- and inter-rater reliability of the assessment of capacity for myoelectric control. Journal of Rehabilitation Medicine. 2006;38(2):118-23.	No results for multi-grip prosthetics
Hermansson L, Eliasson AC, Engstrom I. Psychosocial adjustment in Swedish children with upper-limb reduction deficiency and a myoelectric prosthetic hand. Acta Paediatrica. 2005;94(4):479-88.	Not assessing a multi-grip prosthetic
Hermansson LM, Fisher AG, Bernspang B, Eliasson AC. Assessment of capacity for myoelectric control: a new Rasch-built measure of prosthetic hand control. Journal of Rehabilitation Medicine. 2005;37(3):166-71.	No results for multi-grip prosthetics
Ku I, Lee GK, Park CY, Lee J, Jeong E. Clinical outcomes of a low-cost single-channel myoelectric-interface three-dimensional hand prosthesis. Archives of Plastic Surgery. 2019;46(5):491.	Device not listed in the information provided by NHS England about devices commercially available in the UK. Excluded as not an eligible device
Kuiken TA, Miller LA, Turner K, Hargrove LJ. A Comparison of Pattern Recognition Control and Direct Control of a Multiple Degree-of-Freedom Transradial Prosthesis. IEEE Journal of Translational Engineering in Health and Medicine. 2016;4:2100508.	No comparison between devices (comparative evidence available for outcomes reported in this paper) and subjects tested after 4 weeks for each control system (<6 weeks)
Lindner HY, Eliasson AC, Hermansson LM. Influence of standardized activities on validity of Assessment of Capacity for Myoelectric Control. Journal of Rehabilitation Research & Development. 2013;50(10):1391-400.	No results for multi-grip prosthetics
Lindner H, Hiyoshi A, Hermansson L. Relation between capacity and performance in paediatric upper limb prosthesis users. Prosthetics & Orthotics International. 2018;42(1):14-20.	Not assessing a multi-grip prosthetic
Lindner HY, Langius-Eklof A, Hermansson LM. Test-retest reliability and rater agreements of assessment of capacity for myoelectric control version 2.0. Journal of Rehabilitation Research & Development. 2014;51(4):635-44.	No results for multi-grip prosthetics
Lindner HY, Linacre JM, Norling Hermansson LM. Assessment of capacity for myoelectric control: evaluation of construct and rating scale. Journal of Rehabilitation Medicine. 2009;41(6):467-74.	Not assessing a multi-grip prosthetic
Major MJ, McConn SM, Zavaleta JL, Stine R, Gard SA. Effects of upper limb loss and prosthesis use on proactive mechanisms of locomotor stability. Journal of Electromyography & Kinesiology. 2019;48:145-51.	Participants used different types of prosthetics. No outcomes reported by type of prosthetic
Major MJ, Stine RL, Heckathorne CW, Fatone S, Gard SA. Comparison of range-of-motion and variability in upper body movements between transradial prosthesis users and able-bodied controls when executing goal-oriented tasks. Journal of Neuroengineering & Rehabilitation. 2014;11:132.	No results for multi-grip prosthetics

Markovic M, Schweisfurth MA, Engels LF, Bentz T, Wustefeld D, Farina D, et al. The clinical relevance of advanced artificial feedback in the control of a multi-functional myoelectric prosthesis. Journal of Neuroengineering & Rehabilitation. 2018;15(1):28.	Testing in laboratory setting without a period of device utilisation
Mastinu E, Clemente F, Sassu P, Aszmann O, Branemark R, Hakansson B, et al. Grip control and motor coordination with implanted and surface electrodes while grasping with an osseointegrated prosthetic hand. Journal of Neuroengineering & Rehabilitation. 2019;16(1):49.	Not assessing a multi-grip prosthetic
McFarland LV, Hubbard Winkler SL, Heinemann AW, Jones M, Esquenazi A. Unilateral upper-limb loss: satisfaction and prosthetic-device use in veterans and service members from Vietnam and OIF/OEF conflicts. Journal of Rehabilitation Research & Development. 2010;47(4):299-316.	Multiple device types. No separate results for multi-grip prosthetics
Miller LA, Stubblefield KA, Lipschutz RD, Lock BA, Kuiken TA. Improved myoelectric prosthesis control using targeted reinnervation surgery: a case series. IEEE Transactions on Neural Systems & Rehabilitation Engineering. 2008;16(1):46-50.	No results for multi-grip prosthetics
Ninu A, Dosen S, Muceli S, Rattay F, Dietl H, Farina D. Closed-loop control of grasping with a myoelectric hand prosthesis: which are the relevant feedback variables for force control? IEEE Transactions on Neural Systems & Rehabilitation Engineering. 2014;22(5):1041-52.	Not assessing a multi-grip prosthetic
Okuno R, Yoshida M, Akazawa K. Compliant grasp in a myoelectric hand prosthesis. Controlling flexion angle and compliance with electromyogram signals. IEEE Engineering in Medicine & Biology Magazine. 2005;24(4):48-56.	Not assessing a multi-grip prosthetic
Ostlie K, Lesjo IM, Franklin RJ, Garfelt B, Skjeldal OH, Magnus P. Prosthesis use in adult acquired major upper-limb amputees: patterns of wear, prosthetic skills and the actual use of prostheses in activities of daily life. Disability & Rehabilitation Assistive Technology. 2012;7(6):479-93.	Participants used different types of prosthetics. No results presented by type of grip
Otto IA, Kon M, Schuurman AH, van Minnen LP. Replantation versus Prosthetic Fitting in Traumatic Arm Amputations: A Systematic Review. PLoS ONE. 2015;10(9):e0137729.	Review of transplantation and prosthetics studies. No reporting of outcomes by prosthetic type
Postema SG, van der Sluis CK, Waldenlov K, Norling Hermansson LM. Body structures and physical complaints in upper limb reduction deficiency: a 24-year follow-up study. PLoS ONE [Electronic Resource]. 2012;7(11):e49727.	No results for multi-grip prosthetics
Pylatiuk C, Schulz S, Doderlein L. Results of an Internet survey of myoelectric prosthetic hand users. Prosthetics & Orthotics International. 2007;31(4):362-70.	No results for multi-grip prosthetics
Resnik L, Baxter K, Borgia M, Mathewson K. Is the UNB test reliable and valid for use with adults with upper limb amputation? Journal of Hand Therapy. 2013;26(4):353-9; quiz 9.	Multiple device types. No separate results for multi-grip prosthetics
Resnik L, Borgia M, Acluche F. Brief activity performance measure for upper limb amputees: BAM-ULA. Prosthetics & Orthotics International. 2018;42(1):75-83.	Multiple device types. No separate results for multi-grip prosthetics
Resnik L, Ekerholm S, Borgia M, Clark MA. A national study of Veterans with major upper limb amputation: Survey methods, participants, and summary findings. PLoS ONE. 2019;14(3):e0213578.	Multiple device types. No separate results for multi-grip prosthetics
Ritchie S, Wiggins S, Sanford A. Perceptions of cosmesis and function in adults with upper limb prostheses: a systematic literature review. Prosthetics & Orthotics International. 2011;35(4):332-41.	Broad review of studies about various prosthetics. No separate results for multi-grip prosthetics. Any individual studies potentially in scope considered separately
Segil JL, Huddle SA, Weir RFF. Functional Assessment of a Myoelectric Postural Controller and Multi-Functional Prosthetic Hand by Persons With Trans-Radial Limb Loss. IEEE Transactions on Neural Systems & Rehabilitation Engineering. 2017;25(6):618-27.	Testing in laboratory setting without a period of device utilisation
Simon AM, Turner KL, Miller LA, Hargrove LJ, Kuiken TA. Pattern recognition and direct control home use of a multi-articulating hand prosthesis. IEEE International Conference on Rehabilitation Robotics. 2019;2019:386-91.	Not assessing outcomes specified in PICO

Sjoberg L, Lindner H, Hermansson L. Long-term results of early myoelectric prosthesis fittings: A prospective case-control study. Prosthetics & Orthotics International. 2018;42(5):527-33.	Not assessing a multi-grip prosthetic
Smail LC, Neal C, Wilkins C, Packham TL. Comfort and function remain key factors in upper limb prosthetic abandonment: findings of a scoping review. Disability & Rehabilitation Assistive Technology. 2020:1-10.	Broad review of studies about various prosthetics. No results presented by type of grip. Any individual studies potentially in scope considered separately
Vujaklija I, Roche AD, Hasenoehrl T, Sturma A, Amsuess S, Farina D, et al. Translating Research on Myoelectric Control into Clinics-Are the Performance Assessment Methods Adequate? Frontiers in Neurorobotics. 2017;11:7.	Testing in laboratory setting without a period of device utilisation
Widehammar C, Pettersson I, Janeslatt G, Hermansson L. The influence of environment: Experiences of users of myoelectric arm prosthesis-a qualitative study. Prosthetics & Orthotics International. 2018;42(1):28-36.	Not assessing a multi-grip prosthetic

Appendix E Evidence Table

For abbreviations see list after table

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
Luchetti M, Cutti AG, Verni G, Sacchetti R, Rossi N. Impact of Michelangelo prosthetic hand: findings from a crossover longitudinal study. JRRD 2015; 52(5):605-618. 1 centre, Italy Longitudinal crossover study The study aim was to provide preliminary evidence of the potential benefits of the Michelangelo myoelectric multi-grip 'hand wrist system' in comparison with traditional (single grip) myoelectric solutions in a sample of participants with transradial amputation Study dates not stated	Participants with unilateral transradial upper limb amputation Inclusion criteria Age 18-65 (active workers), active prosthetic user, work-related unilateral transradial amputation with preserved function of contralateral limb, stabilised residual limb, presence of at least 1 usable electromyography signal, ability to suspend work activity for period of occupational therapy and testing and ability to travel to and stay at the prosthetic centre Exclusion criteria None stated	Intervention Myoelectric multi-grip prosthetic hand (Michelangelo) Participants received occupational therapy (training) for 4 hours a day for 5 days after receipt of the multi-grip prosthetic **Comparison** Baseline tests were conducted using the participant's existing myoelectric single grip prosthetic hand Duration of use or any training received for the myoelectric single grip prosthetic not reported	**Critical outcomes** **Functional outcome measures** All functional outcomes reported using the participant's existing myoelectric single grip prosthetic at baseline and a myoelectric multi-grip prosthetic after 3 months utilisation ***BBT[35] median (range)*** • Myoelectric multi-grip: 29.0 (26 to 33) • Myoelectric single grip: 24.0 (19 to 30) $p<0.05$ The study authors stated that 4 (of 6) participants showed an improvement larger than the "minimum detectable change" (≥6.46) ***MMDT[36] median (range)*** • Myoelectric multi-grip: 138.5 (120 to 165) seconds • Myoelectric single grip: 162.5 (130 to 297) seconds $p<0.05$	This study was appraised using the JBI checklist for quasi-experimental studies 1. Yes 2. Yes 3. Yes 4. Not applicable 5. No 6. Yes 7. Yes 8. Yes 9. Yes **Other comments**: This was an observational study with no random assignment of participants to order of testing. This introduces a potential practice effect as all participants gained experience of the assessment measures using the single grip prosthetic before assessment with the multi-grip prosthetic. The outcome assessments included a combination of

[35] BBT assesses arm/hand dexterity through the number of wooden blocks moved from one area to another in 1 minute. Higher scores indicate higher functionality
[36] MMDT assesses arm/hand dexterity through the time taken (in seconds) to place 60 round pegs into holes. Lower scores indicate higher functionality

Study details	Population	Intervention	Study outcomes	Appraisal and Funding

	Total sample size
	6
	
	Baseline characteristics
	
	• Male: 100%
	• Median age: 47 years (range 35 to 65)
	• Median time since amputation: 15 years (range 4.5 to 48.0)
	• Employment:
	  • Unemployed: 33%
	  • Office worker: 33%
	  • Businessman: 17%
	  • Retired: 17%
			SHAP[37] index of functionality median (range)
			• Myoelectric multi-grip: 83.0 (76 to 88)
			• Myoelectric single grip: 74.5 (43 to 84)
			$p<0.05$
			
			DASH[38]
			The authors stated that participants "showed low DASH scores in all assessments, with values always lower than 26 points; differences between assessments remained always smaller than the minimum detectable change (10.7 points)". The study authors did not provide any further details relating to this result
			
			OPUS-UEFS[39]
			The authors stated that "an easier execution of activities of daily living were reported with the myoelectric multi-grip prosthetic by 5 of 6 participants (from -0.48 to -8.86 points)" No further detail reported
			
			Quality of life
			
			All quality of life outcomes reported using the participant's existing myoelectric single grip
				objective tests and self-report measures. There was a single measurement point for outcome assessments using each prosthetic providing a snapshot of functional ability or self-reported quality of life and satisfaction at that time. Caution should be exercised in drawing wider, longer-term conclusions.
				
				The sample size was small and all participants were male adults. The study dates were not stated. The generalisability of the results is not clear.
				
				Multiple functional outcome measures were reported. Measures reported as a composite and/or total score were extracted for this review.
				
				Baseline data were collected on performance with the intact hand. These results were not extracted for this review.

[37] SHAP assesses hand dexterity in 12 abstract object tasks and 14 activities of daily living. Time in seconds to complete each task is inputted into a scoring chart that calculates an overall index of functionality. Higher scores indicate higher functionality
[38] DASH assesses upper limb physical function in activities of daily living using a 30-item self-report questionnaire (DASH is listed as a functional outcome measure in the PICO). Scores range from 0 (no disability) to 100 (most severe disability) with lower scores indicating higher functionality. The PICO states that the minimally clinical important difference is an improvement in DASH score of >14
[39] OPUS-UEFS assesses upper limb physical function in activities of daily living using a 23-item self-report questionnaire. Scores range from 0 to 100 with lower scores indicating higher functionality

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
			prosthetic at baseline and a myoelectric multi-grip prosthetic after 6 months experience ***EuroQoL EQ-5D[40] median (range)*** • Summary index • Myoelectric multi-grip: 0.858 (0.539 to 0.919) • Myoelectric single grip: 0.901 (0.796 to 0.919) • Visual analogue scale • Myoelectric multi-grip: 90.0 (70 to 100) • Myoelectric single grip: 87.5 (70 to 100) No significant difference between type of prosthetic (p>0.05) ***HADS[41] median (range)*** • Anxiety • Myoelectric multi-grip: 2.0 (0 to 9) • Myoelectric single grip: 2.0 (0 to 7) • Depression • Myoelectric multi-grip: 3.5 (0 to 6) • Myoelectric single grip: 2.5 (1 to 5) No significant difference between type of prosthetic (p>0.05) **Important outcomes**	**Source of funding:** A funding agreement with Ottobock Healthcare Products GmbH partially supported the study. The authors state that Ottobock Healthcare Products GmbH was not involved in the study design, data collection, data analysis, interpretation of results, writing of the article or decision to submit the article for publication in the journal.

[40] EuroQoL EQ-5D assesses self-reported health-related quality of life for 5 items (mobility, self-care, usual activities, pain and discomfort, and anxiety and depression). A summary index scored from 0 to 1 and a visual analogue scale from 0 to 100 were used to rate perceived health status. Higher scores indicate higher quality of life
[41] HADS assesses anxiety and depression using a 14-item self-report questionnaire. Scores range from 0 to 21 with lower scores indicating less anxiety or depression. The authors gave a cut-off of ≥ 8 for considering participants to be anxious or depressed

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
			Patient satisfaction and prosthetic acceptability All satisfaction outcomes reported using the participant's existing myoelectric single grip prosthetic at baseline and a myoelectric multi-grip prosthetic after 6 months experience **TAPES-SAT[42] *median (range)*** • Myoelectric multi-grip: 43 (27 to 46) • Myoelectric single grip: 43 (35 to 45) No significant difference between type of prosthetic (p>0.05) ***ABIS[43] median (range)*** • Myoelectric multi-grip: 36.0 (33 to 50) • Myoelectric single grip: 34.0 (33 to 48) No significant difference between type of prosthetic (p>0.05) **Device durability** 4 of 6 participants (66.7%) experienced at least 1 temporary failure of the myoelectric multi-grip prosthetic over the 6-month study period. No further detail reported	

[42] TAPES-SAT is a 10-item self-report questionnaire assessing prosthetic satisfaction through colour, shape, noise, appearance, weight, usefulness, reliability, fit, comfort and overall satisfaction. Items are rated on a 5-point scale from 1 (very dissatisfied) to 5 (very satisfied) with higher scores indicating higher satisfaction
[43] ABIS assesses body image concerns using a 20-item self-report questionnaire. Scores range from 20 to 100 with lower scores indicating fewer concerns

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
Resnik L, Borgia M, Biester S, Clark M. Longitudinal study of prosthesis use in veterans with upper limb amputation. Prosthetics & Orthotics International 2020a:309364620957920. USA Longitudinal survey The study aim was to describe changes in prosthetic use over 1 year Participants received care from the Department of Veterans Affairs between 2010 and 2015	Participants with major upper limb amputation from a national sample of veterans who completed a baseline and follow-up survey about prosthetic use Inclusion criteria All veterans with a diagnosis of major upper limb amputation who received care in the Department of Veterans Affairs between 2010 and 2015 Exclusion criteria None stated Total sample size 585 Outcomes by prosthetic type extracted (n=295) Baseline characteristics (n=585) • Male: 98.3% • Mean (SD) age: 63.7 (13.6) years	Intervention Myoelectric multi-grip prosthetic (e.g. I-limb, Michelangelo and Bebionic hands) (n=33) **Comparison** **Single grip prosthetic:** • Myoelectric single grip (powered hook) (n=14) • Myoelectric single grip (Sensor speed) (n=10) • Myoelectric single grip (Greifer) (n=6) • Body powered single grip prosthetic (hook) (n=232) No details of training received by prosthetic type reported	**Important outcomes** **Prosthetic abandonment** Percentage of respondents using a different prosthetic at 12-months follow-up, reported by prosthetic used at baseline: • Myoelectric multi-grip: 58% • Myoelectric single grip (powered hook): 43% • Myoelectric single grip (Sensor speed): 40% • Myoelectric single grip (Greifer): 67% • Body powered single grip: 20% No statistical tests reported An indication of the prosthetic type used at follow-up was only provided graphically	This study was appraised using the JBI checklist for analytical cross-sectional studies[44] 1. Yes 2. Yes 3. Unclear 4. Yes 5. No 6. No 7. No 8. No **Other comments:** This was a survey of US veterans and participants were predominantly male. The outcome of interest for this review was only reported for participants who completed a baseline and follow-up interview. However, the response rate for completing both surveys was 72%. People who chose to participate and complete both surveys may not be representative of the wider population. Although some details were provided about the study population, they were not reported by type of prosthetic used. Results for different myoelectric multi-grip prosthetics

[44] This checklist was used as this study in relation to the outcome reported was essentially a cross-sectional assessment of whether participants were still using the same prostheti

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
	• Mean (SD) years since amputation: 31.7 (18.0) • Employment: • Employed full time: 9.4% • Employed part time: 4.1% • Student: 2.6% • Retired, but employed after amputation: 51.3% • Retired, but not employed after amputation: 20.0% • On medical leave: 0.9% • Other: 11.6% • Unknown: 0.2% **Laterality of amputation (n=585):** • Unilateral right: 46.7% • Unilateral left: 49.4% • Bilateral: 3.9% **Amputation level (n=585):** • Below elbow: 37.6%			were presented as one group but results for myoelectric single grip prosthetics were only reported by model of device. No statistical analysis was performed. For participants with bilateral amputation, the study authors used the prosthetic on the dominant side for analysis. All data on prosthetic type and outcomes were self-reported and the study authors did not collect data on why prosthetics were abandoned. Potential confounding factors were not reported. Data on the prosthetic types used at baseline and follow-up were only provided graphically without numerical values to clarify which type of prosthetic participants were changing to. There was a single outcome assessment point providing a snapshot of the participant's circumstances at that time. Caution should be exercised in drawing wider, longer-term conclusions. **Source of funding:** The research was funded through the Orthotics and Prosthetics Outcomes Research Program Prosthetics Outcomes Research Award and the Department of Veterans Affairs

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
	• Above elbow: 31.4% • Wrist disarticulation: 18.1% • Shoulder disarticulation: 8.0% • Elbow disarticulation: 5.3% • Forequarter amputation: 3.2%			Rehabilitation Research and Development Service.
Resnik L, Borgia M, Cancio J, Heckman J, Highsmith J, Levy C, Philips S, Webster J. Dexterity, activity performance, disability, quality of life and independence in upper limb veteran prosthesis users: a normative study. Disability and Rehabilitation 2020b; 1-12. 5 sites, USA Cross-sectional study The study aim was to present population data	Participants with major upper limb amputation Inclusion criteria Persons with major upper limb loss who used an active prosthetic Exclusion criteria Unable to tolerate wearing of prosthetic for ≥3 hours; severe health condition that might limit ability to participate in study assessment activities	Intervention Myoelectric multi-grip prosthetic (I-limb, Michelangelo, Bebionic hands, LUKE Arm[45]) (n=25) **Comparison** **Single grip prosthetic:** • Myoelectric single grip (electronic terminal devices, Greifers, Sensor speed hands) (n=27) • Body powered single grip	Data were only reported separately for participants with transradial and transhumeral amputations. The first 3 functional measures were also reported separately for all participants (unilateral and bilateral amputees) and for unilateral amputees only. Other measures were reported for unilateral amputees only. All significance tests compare scores across the 3 prosthetic types **Critical outcomes** **Functional outcome measures** ***BBT mean (SD)*** *For unilateral and bilateral amputees* Transradial: • Myoelectric multi-grip (n=19): 15.4 (6.0) • Myoelectric single grip (n=15): 15.1 (9.1)	This study was appraised using the JBI checklist for analytical cross-sectional studies 1. Yes 2. No 3. Yes 4. Yes 5. Yes 6. No 7. Yes 8. No **Other comments**: This was an observational study with no random assignment of participants to prosthetic type and no pairwise statistical analysis was performed

[45] One of these devices, the LUKE Arm, is not commercially available in the UK. The number of participants using the different types of myoelectric control multi-grip devices was not stated

Study details	Population	Intervention	Study outcomes	Appraisal and Funding

on standardised measures and examine differences by prosthetic type and laterality
 	
Study dates not stated
	Total sample size
	
	127
	
	Baseline characteristics
	
	• Male: 96.9%
	• Mean (SD) age: 56.9 (16.5) years
	• Mean (SD) years since amputation: 22.6 (18.9)
	• Employment:
	  • Employed full time: 17.3%
	  • Employed part time: 3.9%
	  • Student: 4.7%
	  • Retired, but employed after amputation: 36.2%
	  • Retired, but not employed after amputation: 14.2%
	  • On medical leave: 5.5%
	  • Unknown: 18.1%
		prosthetic (hook) (n=75)
		
		26.0% of participants had received training to use their current prosthetic. No details of training received by prosthetic type reported
			• Body powered single grip (n=53): 20.6 (9.2)
			p=0.02
			Transhumeral:
			• Myoelectric multi-grip (n=5): 7.6 (6.5)
			• Myoelectric single grip (n=10): 5.2 (5.7)
			• Body powered single grip (n=20): 11.8 (9.8)
			p=0.21
			
			For unilateral amputees only
			Transradial:
			• Myoelectric multi-grip (n=18): 15.3 (6.2)
			• Myoelectric single grip (n=12): 14.3 (7.9)
			• Body powered single grip (n=45): 19.0 (8.7)
			p=0.065
			Transhumeral:
			• Myoelectric multi-grip (n=5): 7.6 (6.5)
			• Myoelectric single grip (n=9): 4.0 (4.5)
			• Body powered single grip (n=18): 10.5 (9.3)
			p=0.22
			
			Nine Hole Peg Test[46] (mean items per second) mean (SD)
			For unilateral and bilateral amputees
			Transradial:
				comparing individual types of prosthetic. The authors controlled for multiple comparisons in the analysis.
				
				Participants using different prosthetic models were grouped together and the analysis did not account for potential confounding factors such as receipt of training or experience of prosthetic use.
				
				The authors did not state whether bilateral amputees were tested using the prosthetic on the dominant side.
				
				The outcome assessments included a combination of objective tests and self-report measures. This was a cross-sectional study providing a snapshot of functional ability or self-reported quality of life and satisfaction at that time. Participants were assessed using their own existing prosthetic. User need may determine choice of prosthetic so the comparisons between types of prosthetic should be interpreted with caution.

[46] The Nine Hole Peg Test assesses arm/hand dexterity through the time taken to accurately place and remove 9 pegs into and from a pegboard. Mean score calculated as items per second. Higher scores indicate higher functionality

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
	Laterality of amputation: • Unilateral: 88.1% • Bilateral: 11.8% **Amputation level:** • Transradial: 68.5% • Transhumeral: 27.6% • Shoulder: 3.9%		• Myoelectric multi-grip (n=19): 0.01 (0.01) • Myoelectric single grip (n=15): 0.06 (0.06) • Body powered single grip (n=53): 0.07 (0.06) p=0.0001 Transhumeral: • Myoelectric multi-grip (n=5): 0.00 (0.00) • Myoelectric single grip (n=10): 0.01 (0.03) • Body powered single grip (n=20): 0.05 (0.06) p=0.031[47] *For unilateral amputees only* Transradial: • Myoelectric multi-grip (n=18): 0.01 (0.01) • Myoelectric single grip (n=12): 0.06 (0.06) • Body powered single grip (n=45): 0.06 (0.05) p=0.0008 Transhumeral: • Myoelectric multi-grip (n=5): 0.00 (0.00) • Myoelectric single grip (n=9): 0.00 (0.00) • Body powered single grip (n=18): 0.04 (0.04) p=0.02	Study dates and details of the clinics included in the study were not reported. Most participants were male US veterans. The generalisability of the results is not clear. Participants with amputation at the shoulder level were included in the study population but not in the results reported by prosthetic type by the study authors. Participants with bilateral amputation were only included in the reporting of 3 functional measures and only in combination with unilateral amputees. Multiple functional outcome measures were reported. Measures reported as a composite and/or total score were extracted for this review. **Source of funding:** The work was supported by the Orthotics and Prosthetics Outcomes Research Program, Prosthetics Outcomes Research Award.

[47] This result was statistically significant at a p<0.05, but no longer significant after controlling for multiple comparisons

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
			SHAP index of functionality mean (SD) *For unilateral and bilateral amputees* Transradial: • Myoelectric multi-grip (n=19): 39.6 (14.8) • Myoelectric single grip (n=15): 41.0 (21.1) • Body powered single grip (n=53): 44.0 (19.6) p=0.57 Transhumeral: • Myoelectric multi-grip (n=5): 12.8 (12.7) • Myoelectric single grip (n=10): 10.8 (16.6) • Body powered single grip (n=20): 14.4 (15.3) p=0.67 *For unilateral amputees only* Transradial: • Myoelectric multi-grip (n=18): 40.2 (15.0) • Myoelectric single grip (n=12): 39.3 (23.1) • Body powered single grip (n=45): 42.4 (18.4) p=0.83 Transhumeral: • Myoelectric multi-grip (n=5): 12.8 (12.7) • Myoelectric single grip (n=9): 6.6 (10.3) • Body powered single grip (n=18): 13.4 (16.2)	

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
			p=0.54 ***QuickDASH[48] mean (SD)*** *For unilateral amputees* Transradial: • Myoelectric multi-grip (n=18): 26.3 (18.1) • Myoelectric single grip (n=12): 30.9 (15.8) • Body powered single grip (n=45): 29.2 (19.4) p=0.72 Transhumeral: • Myoelectric multi-grip (n=5): 30.5 (13.3) • Myoelectric single grip (n=9): 28.2 (13.8) • Body powered single grip (n=18): 34.0 (20.7) p=0.85 **Activities of daily living** ***AM-ULA[49] mean (SD)*** *For unilateral amputees* Transradial: • Myoelectric multi-grip (n=18): 16.4 (6.5) • Myoelectric single grip (n=12): 14.9 (7.7) • Body powered single grip (n=45): 14.9 (5.3)	

[48] QuickDASH is a self-report questionnaire with 8 items on functional difficulty and 3 items on sleep, sensation and pain. Lower scores indicate higher functionality
[49] AM-ULA is an assessment of activity performance for 18 everyday tasks. Each task is rated on task completion, speed, movement, quality, skilfulness of prosthetic use and independence. Total score is the average score x 10 with higher scores indicating better performance

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
			p=0.68 Transhumeral: • Myoelectric multi-grip (n=5): 11.9 (1.8) • Myoelectric single grip (n=9): 9.4 (4.2) • Body powered single grip (n=18): 12.3 (6.2) p=0.23 ***BAM-ULA[50] mean (SD)*** *For unilateral amputees* Transradial: • Myoelectric multi-grip (n=18): 8.0 (1.6) • Myoelectric single grip (n=12): 9.2 (1.0) • Body powered single grip (n=45): 6.6 (2.1) p=0.002 Transhumeral: • Myoelectric multi-grip (n=5): 3.5 (0.7) • Myoelectric single grip (n=9): 4.0 (not stated) • Body powered single grip (n=18): 4.5 (3.4) p=0.83 ***T-map[51] mean (SD)*** *For unilateral amputees* Transradial: • Myoelectric multi-grip (n=18): 3.9 (0.9) • Myoelectric single grip (n=12): 3.9 (0.6)	

[50] BAM-ULA is an assessment of ability to complete 10 everyday tasks. Total score is the number of completed activities with higher scores indicating better performance
[51] T-map is an assessment of time taken to complete 5 everyday activities. Lower scores indicate better performance

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
			• Body powered single grip (n=45): 5.0 (1.8) p=0.081 Transhumeral: • Myoelectric multi-grip (n=5): 7.4 (3.0) • Myoelectric single grip (n=9): 4.9 (1.2) • Body powered single grip (n=18): 4.6 (1.7) p=0.18 ***Need help with ADL n (%)*** *For unilateral amputees* Transradial: • Myoelectric multi-grip (n=18): 2 (16.7%) • Myoelectric single grip (n=12): 3 (37.5%) • Body powered single grip (n=45): 7 (21.2%) p=0.57 Transhumeral: • Myoelectric multi-grip (n=5): 1 (20%) • Myoelectric single grip (n=9): 2 (28.6%) • Body powered single grip (n=18): 3 (25%) p=1.0 **Quality of life** ***VR-12[52] mental component summary mean (SD)***	

[52] The VR-12 is a 12-item self-report questionnaire assessing health-related quality of life with a mental and physical component summary. Scores range from 1 to 100 with higher scores indicating higher quality of life

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
			For unilateral amputees Transradial: • Myoelectric multi-grip (n=18): 52.4 (11.5) • Myoelectric single grip (n=12): 46.3 (12.8) • Body powered single grip (n=45): 53.5 (10.1) p=0.085 Transhumeral: • Myoelectric multi-grip (n=5): 52.9 (9.4) • Myoelectric single grip (n=9): 50.6 (14.6) • Body powered single grip (n=18): 50.4 (13.1) p=0.98 ***VR-12 physical component summary mean (SD)*** *For unilateral amputees* Transradial: • Myoelectric multi-grip (n=18): 41.1 (8.2) • Myoelectric single grip (n=12): 43.2 (6.9) • Body powered single grip (n=45): 37.5 (8.9) p=0.085 Transhumeral: • Myoelectric multi-grip (n=5): 44.0 (8.1) • Myoelectric single grip (n=9): 41.9 (5.6) • Body powered single grip (n=18): 34.7 (13.2) p=0.17	

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
			Important outcomes **Patient satisfaction and prosthetic acceptability** ***TAPES-SAT mean (SD)*** *For unilateral amputees* Transradial: • Myoelectric multi-grip (n=18): 3.8 (0.7) • Myoelectric single grip (n=12): 3.5 (0.7) • Body powered single grip (n=45): 4.0 (0.7) p=0.051 Transhumeral: • Myoelectric multi-grip (n=5): 3.7 (0.5) • Myoelectric single grip (n=9): 3.5 (0.5) • Body powered single grip (n=18): 3.7 (0.9) p=0.64	
Resnik L, Borgia M, Clark M. Function and quality of life of unilateral major upper limb amputees: effect of prosthesis use and type. Archives of Physical Medicine and Rehabilitation 2020c; 101:1396-1406. USA Cross-sectional survey	Participants with unilateral upper limb amputation from a national sample of veterans Inclusion criteria All veterans with a diagnosis of unilateral major upper limb amputation who received care in the Department of Veterans Affairs	Intervention Myoelectric multi-grip prosthetic (e.g. I-limb, Michelangelo and Bebionic hands) (n=40) 82.5% of participants had received training to use their current myoelectric multi-grip prosthetic. No information was	**Critical outcomes** **Functional outcome measures** *Myoelectric multi-grip vs body powered single grip* ***QuickDASH*** Multi-variate linear regression modelling reported no significant difference between myoelectric multi-grip prosthetic users and body powered single grip prosthetic users (β 1.24, 95%CI -5.88 to 8.36, p=0.7326)	This study was appraised using the JBI checklist for analytical cross-sectional studies 1. Yes 2. Yes 3. Unclear 4. Yes 5. Yes 6. Yes 7. No 8. Yes **Other comments**:

Study details	Population	Intervention	Study outcomes	Appraisal and Funding

The study aim was to compare outcomes of disability, activity difficulty and health-related quality of life by device configuration
 	
Participants received care from the Department of Veterans Affairs between 2010 and 2015
	between 2010 and 2015
	
	Exclusion criteria
	
	Bilateral amputation, unknown, conflicting or ineligible prosthetic type, hearing/cognition impairment, language barrier
	
	Total sample size
	755
	
	Outcomes by prosthetics type extracted (n=365)
	
	Baseline characteristics (n=755)
	
	• Male: 97.2%
	• Mean (±SD) age: 63.5±13.9 years
	• Mean (±SD) time since amputation: 31.4±18.3 years
	• Employment:
	  • Employed full time: 9.4%
	  • Employed part time: 4.0%
	  • Student: 2.3%
	  • Retired, but employed after
		provided on type or duration of training
		
		Comparison
		• Body powered single grip (n=325)
		• Myoelectric multi-grip users without a prosthetic (n=40)
		
		64.0% of participants had received training to use their current body powered single grip prosthetic. No information was provided on type or duration of training
			Myoelectric multi-grip vs no prosthetic
			
			QuickDASH
			No significant difference for the self-reported performance of two-handed tasks for myoelectric multi-grip prosthetic users wearing their prosthetic vs not wearing their prosthetic: Mean ± SD
			• Lift and carry bulky objects: 2.8±1.3 vs 2.7±1.1, p=0.67
			• Spread peanut butter: 3.1±1.4 vs 3.3±1.3, p=0.60
			• Do housework: 2.5±1.1 vs 2.8±1.2, p=0.12
			
			Significantly better scores for the self-reported performance of one-handed tasks for myoelectric multi-grip prosthetic users wearing their prosthetic vs using the remaining residual limb without prosthetic: Mean ± SD
			• Pick up small objects: 3.5±1.1 vs 4.5±1.1, p=0.0008
			• Grasp rounded objects: 2.6±1.2 vs 4.1±1.2, p<0.0001
			
			Activities of daily living
			
			Myoelectric multi-grip vs body powered single grip
			
			Multi-variate logistic modelling showed no significant difference between myoelectric multi-grip prosthetic users and body powered single grip prosthetic users in help needed
				This was a survey of US veterans and participants were predominantly male. The response rate was 48%. People who chose to participate may not be representative of the wider population.
				
				All data on prosthetic type and outcomes were self-reported. This was a cross-sectional study providing a snapshot of functional ability, activities of daily living or quality of life at that time. Participants were assessed using their own existing prosthetic. User need may determine choice of prosthetic so the comparisons between types of prosthetic should be interpreted with caution.
				
				Regression models were controlled for age, years since amputation, race, marital status, amputation level, ever having used a prosthetic, lower limb amputation, amputation of dominant side, amputation aetiology, initial and current prosthetic training, year of prosthetic receipt and number of prosthetics.
				
				Multiple functional outcome measures were reported. Measures reported as a composite and/or total score with statistical comparison between

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
	amputation: 48.7% • Retired, but not employed after amputation: 19.9% • On medical leave: 1.2% • Other: 12.1% • Unknown: 2.5% **Amputation level (n=755):** • Below elbow: 35.8% • Above elbow: 30.9% • Wrist disarticulation: 16.4% • Shoulder disarticulation: 9.1% • Elbow disarticulation: 4.9% • Forequarter amputation: 2.9%		with daily activities (OR 1.75, 95%CI 0.81 to 3.79, p=0.1557) **Quality of life** *Myoelectric multi-grip vs body powered single grip* ***VR-12*** • Mental component summary Multi-variate linear regression modelling showed no significant difference between myoelectric multi-grip prosthetic users and body powered single grip prosthetic users (β 2.59, 95%CI -2.14 to 7.32, p=0.2825) • Physical component summary Multi-variate linear regression modelling showed no significant difference between myoelectric multi-grip prosthetic users and body powered single grip prosthetic users (β -0.97, 95%CI -3.99 to 2.05, p=0.5295)	the intervention (myoelectric multi-grip) and a single comparator were extracted for this review. An exception was made for the QuickDASH tasks scores (non-composite) for the comparison of myoelectric multi-grip users with their prosthetic on and with no prosthetic use as these were the only directly comparative data available for this comparison. **Source of funding:** The research was funded by the US Army Medical Research Acquisition Activity.
Resnik L, Borgia M, Heinemann AW, Clark M. Prosthesis satisfaction in a national sample of veterans with upper limb amputation. Prosthetics	Participants with unilateral upper limb amputation from a national sample of veterans	Intervention Myoelectric multi-grip prosthetic (e.g. I-limb, Michelangelo and Bebionic hands) (n=40)	**Important outcomes** **Patient satisfaction and prosthetic acceptability**	This study was appraised using the JBI checklist for analytical cross-sectional studies 1. Yes 2. Yes 3. Unclear

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
and Orthotics International 2020d; 44(2):81-91 USA Cross-sectional survey The study aim was to describe and compare device satisfaction by device type Participants received care from the Department of Veterans Affairs between 2010 and 2015	Inclusion criteria All veterans with a diagnosis of unilateral major upper limb amputation who use a prosthetic and who received care in the Department of Veterans Affairs between 2010 and 2015 Exclusion criteria Bilateral amputation, unknown, conflicting or ineligible prosthetic type, hearing/cognition impairment, language barrier, no prosthetic use Total sample size 449 Outcomes by prosthetic type extracted (n=404) Baseline characteristics (n=449)	**Comparison** **Single grip prosthetic:** • Myoelectric single grip (n=30) • Any single grip (myoelectric or body powered) (n=364) Details of training received for current prosthetic not reported by prosthetic type categories used in the analysis. However, 64.7% of participants had received training to use their current body powered single grip prosthetic and 76.3% of myoelectric prosthetic users (multi-grip or single grip) had received training. No information was provided on type or duration of training.	*Myoelectric multi-grip vs myoelectric single grip* ***TAPES-SAT*** Bi-variate linear regression modelling showed no significant difference between myoelectric multi-grip prosthetic users and myoelectric single grip prosthetic users (β 0.11 (CI not reported) p=0.4812) ***OPUS-CSD***[53] Bi-variate linear regression modelling showed no significant difference between myoelectric multi-grip prosthetic users and myoelectric single grip prosthetic users (β -0.57 (CI not reported) p=0.9023) *Myoelectric multi-grip vs any single grip (myoelectric or body powered)* ***TAPES-SAT*** Bi-variate linear regression modelling showed no significant difference between multi-grip prosthetic users and any single grip prosthetic users (β -0.07 (CI not reported) p=0.5286) ***OPUS-CSD*** Bi-variate linear regression modelling showed no significant difference between multi-grip prosthetic users and any single grip	4. Yes 5. Yes 6. No 7. No 8. Yes **Other comments:** This was a survey of US veterans and participants were predominantly male. The response rate was 48%. People who chose to participate may not be representative of the wider population. All data on prosthetic type and outcomes were self-reported. This was a cross-sectional study providing a snapshot of satisfaction at that time. Participants were assessed using their own existing prosthetic. User need may determine choice of prosthetic so the comparisons between types of prosthetic should be interpreted with caution. The regression modelling available by device type did not include adjustment for potential confounding factors.

[53] A modified version of the OPUS-CSD self-report questionnaire was used with 8-items assessing prosthetic satisfaction through fit, weight, comfort, donning ease, appearance, durability, skin irritation and pain. Items are rated on a 4-point scale from 1 (strongly agree) to 4 (strongly disagree) with lower scores indicating higher satisfaction

Study details	Population	Intervention	Study outcomes	Appraisal and Funding

	• Male: 98.2%
	• Mean (±SD) age: 63.4±13.8 years
	• Mean (±SD) time since amputation: 33.5±18.2 years
	• Employment:
	  • Employed full time: 11.4%
	  • Employed part time: 4.2%
	  • Student: 1.6%
	  • Retired, but employed after amputation: 53.0%
	  • Retired, but not employed after amputation: 16.9%
	  • On medical leave: 0.7%
	  • Other: 8.9%
	  • Unknown: 3.3%
	
	Amputation level (n=449):
	• Below elbow: 46.3%
	• Above elbow: 22.1%
	• Wrist disarticulation: 21.4%
			prosthetic users (β 1.58 (CI not reported) p=0.6043)	Measures reported as a composite and/or total score with statistical comparison between the intervention and a comparator were extracted for this review.
				
				Source of funding:
				
				The research was funded by the US Army Medical Research Acquisition Activity.

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
	• Elbow disarticulation: 4.2% • Shoulder disarticulation: 3.6% • Forequarter amputation: 3.5%			
Salminger S, Vujaklija I, Sturma A, Hasenoehrl T, Roche AD, Mayer JA, Hruby LA, Aszmann OC. Functional outcome scores with standard myoelectric prostheses in below-elbow amputees. American Journal of Physical Medicine & Rehabilitation 2019; 98(2):125-9. 1 clinic, country not stated Cross-sectional study The study aim was to report normative outcome data of prosthetic hand function in below elbow amputees using 4 different objective measurements	Participants with unilateral below elbow amputation Inclusion criteria Patients aged ≥18 years recruited from a special outpatient hand clinic with a unilateral below elbow amputation who had used their latest fitted myoelectric prosthetic for ≥1 year Exclusion criteria Significant uncorrectable visual deficits, major communication or neurocognitive deficits	**Intervention** Myoelectric multi-grip prosthetic (Michelangelo) (n=5) No details of training reported **Comparison** Myoelectric single grip prosthetic (SensorHand Speed) (n=8) No details of training reported 4 additional participants used a different myoelectric multi-grip (n=1) or single grip (n=3) prosthetic. These participants were not	**Critical outcomes** **Functional outcome measures** ***BBT*** No significant difference between patients using a myoelectric multi-grip or myoelectric single grip prosthetic (p=0.486). No further details reported ***CPRT***[54] No significant difference between patients using a myoelectric multi-grip or myoelectric single grip prosthetic (p=0.758). No further details reported ***SHAP*** No significant difference between patients using a myoelectric multi-grip or myoelectric single grip prosthetic (p=0.142). No further details reported ***ARAT***[55]	This study was appraised using the JBI checklist for analytical cross-sectional studies 1. Yes 2. No 3. Yes 4. Yes 5. Yes 6. No 7. Yes 8. Yes **Other comments:** This was an observational study with no random assignment of participants to prosthetic type. This was a cross-sectional study providing a snapshot of functional ability at that time. Although the study reported some outcomes by prosthetic type, it was not designed as a

[54] CPRT assess functionality through the time taken to transfer 4 clothespins of various strengths from a horizontal bar to a vertical one. Lower scores indicate higher functionality

[55] ARAT assesses upper limb motor function through 4 sections with different tasks with a maximum score of 57 points. Higher scores indicate higher functionality

Study details	Population	Intervention	Study outcomes	Appraisal and Funding
Study dates not stated	Total sample size 17 Data by prosthetic type reported for 13 participants Baseline characteristics (n=17) • Male: 94.1% • Mean (±SD) age: 26.12±11.2 years • Mean (range) time using a myoelectric control prosthetic: 6.76 (1 to 16) years No details relating to employment reported	included in the comparison by device type which was only reported for the most commonly used devices	No significant difference between patients using a myoelectric multi-grip or myoelectric single grip prosthetic (p=0.243). No further details reported	study to compare different types of prosthetics. Participants were assessed using their own existing prosthetic. User need may determine choice of prosthetic. The analysis did not account for potential confounding factors such as receipt of training or experience of prosthetic use. The comparisons between types of prosthetic should be interpreted with caution. Study dates and country were not reported. Most participants were male. The generalisability of the results is not clear. **Source of funding:** The study was supported by the Christian Doppler Research Foundation, a subdivision of the Austrian Federal Ministry of Economy, Family and Youth, the Austrian Council for Research and Technology Development.

Abbreviations: ABIS: Amputee Body Image Scale, AM-ULA: Activities Measure for Upper Limb Amputation, ARAT: Action Research Arm Test, BAM-ULA: Brief Activities Measure for Upper Limb Amputation, BBT: Box and Block Test; CI: confidence interval, CPRT: Clothespin-relocation test, DASH: Disabilities of the Arm, Shoulder and Hand, EURO-QoL EQ-5D: EURO Quality of Life Questionnaire 5 Dimensions, HADS: Hospital Anxiety and Depression Scale, MMDT: Minnesota Manual Dexterity Test, OPUS-CSD: Orthotics and Prosthetics User Survey Client Satisfaction with Devices Scale; OPUS-UEFS: Orthotics and Prosthetics User Survey-Upper Extremity Functional Status, OR: odds ratio, QuickDASH: Quick Disabilities of the Arm, Shoulder and Hand, SD: standard deviation, SHAP: Southampton Hand Assessment Procedure, T-MAP: Timed Measure of Activity Performance, TAPES-SAT: Trinity Amputation and Prosthesis Experience Scales Satisfaction Scale, VR-12: Veterans 12-item Health Survey

Appendix F Quality appraisal checklists

JBI checklist for analytical cross-sectional studies

1. Were the criteria for inclusion in the sample clearly defined?
2. Were the study subjects and the setting described in detail?
3. Was the exposure measured in a valid and reliable way?
4. Were objective, standard criteria used for measurement of the condition?
5. Were confounding factors identified?
6. Were strategies to deal with confounding factors stated?
7. Were the outcomes measured in a valid and reliable way?
8. Was appropriate statistical analysis used?

JBI checklist for quasi-experimental studies

1. Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?
2. Were the participants included in any comparisons similar?
3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?
4. Was there a control group?
5. Were there multiple measurements of the outcome both pre and post the intervention/exposure?
6. Was follow-up complete and if not, were differences between groups in terms of their follow-up adequately described and analysed?
7. Were the outcomes of participants included in any comparisons measured in the same way?
8. Were outcomes measured in a reliable way?
9. Was appropriate statistical analysis used?

Appendix G GRADE profiles

In adults and children with either congenital upper limb deficiency or acquired upper limb amputation, what is the clinical effectiveness and safety of the myoelectric control multi-grip upper limb prosthetic compared with standard upper limb prosthetics or no prosthetic use?

Table 1: Myoelectric control multi-grip prosthetics vs myoelectric single grip prosthetics

QUALITY					Summary of findings			IMPORTANCE	CERTAINTY
					No of patients		Effect		
Study	Risk of bias	Indirectness	Inconsistency	Imprecision	Myoelectric multi-grip prosthetics	Myoelectric single grip prosthetics	Result		
Functional outcome measures (1 longitudinal crossover study, 1 cross-sectional study)									
BBT median (range) using existing myoelectric single grip prosthetic at baseline and after 3 months experience with a myoelectric multi-grip prosthetic (benefit indicated by a higher result)									
1 longitudinal crossover study Luchetti et al 2015	Serious limitations[1]	No serious indirectness	Not applicable	Not calculable	6	6	Myoelectric multi-grip 29.0 (26 to 33) vs myoelectric single grip 24.0 (19 to 30) ($p<0.05$) The authors stated that 4/6 participants showed an improvement (with the multi-grip prosthetic) larger than the “minimum detectable change” (≥6.46)	Critical	Very low
BBT (single timepoint) (benefit indicated by a higher result)									
1 cross-sectional study Salminger et al 2019	Very serious limitations[2]	No serious indirectness	Not applicable	Not calculable	5	8	Myoelectric multi-grip vs myoelectric single grip: p=0.486. No further details reported	Critical	Very low
MMDT median (range) using existing myoelectric single grip prosthetic at baseline and after 3 months experience with a myoelectric multi-grip prosthetic (benefit indicated by a lower result)									
1 longitudinal crossover study	Serious limitations[1]	No serious indirectness	Not applicable	Not calculable	6	6	Myoelectric multi-grip 138.5 (120 to 165) vs myoelectric single grip 162.5 (130 to 297) ($p<0.05$)	Critical	Very low

Luchetti et al 2015									
CPRT (single timepoint) (benefit indicated by a lower result)									
1 cross-sectional study Salminger et al 2019	Very serious limitations[2]	No serious indirectness	Not applicable	Not calculable	5	8	Myoelectric multi-grip vs myoelectric single grip: p=0.758. No further details reported	Critical	Very low
SHAP index of functionality median (range) using existing myoelectric single grip prosthetic at baseline and after 3 months experience with a myoelectric multi-grip prosthetic (benefit indicated by a higher result)									
1 longitudinal crossover study Luchetti et al 2015	Serious limitations[1]	No serious indirectness	Not applicable	Not calculable	6	6	Myoelectric multi-grip 83.0 (76 to 88) vs myoelectric single grip 74.5 (43 to 84) (p<0.05)	Critical	Very low
SHAP (single timepoint) (benefit indicated by a higher result)									
1 cross-sectional study Salminger et al 2019	Very serious limitations[2]	No serious indirectness	Not applicable	Not calculable	5	8	Myoelectric multi-grip vs myoelectric single grip: p=0.142. No further details reported	Critical	Very low
ARAT (single timepoint) (benefit indicated by a higher result)									
1 cross-sectional study Salminger et al 2019	Very serious limitations[2]	No serious indirectness	Not applicable	Not calculable	5	8	Myoelectric multi-grip vs myoelectric single grip: p=0.243. No further details reported	Critical	Very low
DASH using existing myoelectric single grip prosthetic at baseline and after 3 months experience with a myoelectric multi-grip prosthetic (benefit indicated by a lower result)									
1 longitudinal crossover study Luchetti et al 2015	Very serious limitations[3]	No serious indirectness	Not applicable	Not calculable	6	6	The authors stated that participants “showed low DASH scores in all assessments, with values always lower than 26 points; differences between assessments remained always smaller than the minimum detectable change (10.7 points)”. The study authors did not provide	Critical	Very low

							any further details relating to this result.		
OPUS-UEFS using existing myoelectric single grip prosthetic at baseline and after 3 months experience with a myoelectric multi-grip prosthetic (benefit indicated by a lower result)									
1 longitudinal crossover study Luchetti et al 2015	Very serious limitations[3]	No serious indirectness	Not applicable	Not calculable	6	6	The authors stated that "an easier execution of activities of daily living were reported with the myoelectric multi-grip prosthetic by 5 of 6 participants (from -0.48 to -8.86 points)" No further detail reported	Critical	Very low
Quality of life (1 longitudinal crossover study)									
EuroQoL EQ-5D summary index median (range) using existing myoelectric single grip prosthetic at baseline and after 6 months experience with a myoelectric multi-grip prosthetic (benefit indicated by a higher result)									
1 longitudinal crossover study Luchetti et al 2015	Serious limitations[1]	No serious indirectness	Not applicable	Not calculable	6	6	Myoelectric multi-grip 0.858 (0.539 to 0.919) vs myoelectric single grip 0.901 (0.796 to 0.919) (no significant difference, p>0.05)	Critical	Very low
EuroQoL EQ-5D visual analogue scale median (range) using existing myoelectric single grip prosthetic at baseline and after 6 months experience with a myoelectric multi-grip prosthetic (benefit indicated by a higher result)									
1 longitudinal crossover study Luchetti et al 2015	Serious limitations[1]	No serious indirectness	Not applicable	Not calculable	6	6	Myoelectric multi-grip 90.0 (70 to 100) vs myoelectric single grip 87.5 (70 to 100) (no significant difference, p>0.05)	Critical	Very low
HADS anxiety median (range) using existing myoelectric single grip prosthetic at baseline and after 6 months' experience with a myoelectric multi-grip prosthetic (benefit indicated by a lower result)									
1 longitudinal crossover study Luchetti et al 2015	Serious limitations[1]	No serious indirectness	Not applicable	Not calculable	6	6	Myoelectric multi-grip 2.0 (0 to 9) vs myoelectric single grip 2.0 (0 to 7) (no significant difference, p>0.05)	Critical	Very low
HADS depression median (range) using existing myoelectric single grip prosthetic at baseline and after 6 months' experience with a myoelectric multi-grip prosthetic (benefit indicated by a lower result)									
1 longitudinal crossover study	Serious limitations[1]	No serious indirectness	Not applicable	Not calculable	6	6	Myoelectric multi-grip 3.5 (0 to 6) vs myoelectric single grip 2.5 (1 to 5) (no significant difference, p>0.05)	Critical	Very low

Luchetti et al 2015									
Patient satisfaction and prosthetic acceptability (1 longitudinal crossover study, 1 cross-sectional survey)									
TAPES-SAT median (range) using existing single grip prosthetic at baseline and after 6 months experience with a myoelectric multi-grip prosthetic (benefit indicated by a higher result)									
1 longitudinal crossover study Luchetti et al 2015	Serious limitations[1]	No serious indirectness	Not applicable	Not calculable	6	6	Myoelectric multi-grip 43 (27 to 46) vs myoelectric single grip 43 (35 to 45) (no significant difference, p>0.05)	Important	Very low
TAPES-SAT assessed by bi-variate linear regression modelling (single timepoint)									
1 cross-sectional survey Resnik et al 2020d	Very serious limitations[4]	No serious indirectness	Not applicable	Not calculable	40	30	Myoelectric multi-grip vs myoelectric single grip (β 0.11, CI not reported) (p=0.4812)	Important	Very low
ABIS median (range) using existing single grip prosthetic at baseline and after 6 months experience with a myoelectric multi-grip prosthetic (benefit indicated by a lower result)									
1 longitudinal crossover study Luchetti et al 2015	Serious limitations[1]	No serious indirectness	Not applicable	Not calculable	6	6	Myoelectric multi-grip 36.0 (33 to 50) vs myoelectric single grip 34.0 (33 to 48) (no significant difference, p>0.05)	Important	Very low
OPUS-CSD assessed by bi-variate linear regression modelling (single timepoint)									
1 cross-sectional survey Resnik et al 2020d	Very serious limitations[4]	No serious indirectness	Not applicable	Not calculable	40	30	Myoelectric multi-grip vs myoelectric single grip (β -0.57, CI not reported) (p=0.9023)	Important	Very low
Device durability (1 longitudinal crossover study)									
Temporary failure of the multi-grip prosthetic during the 6-month study period									
1 longitudinal crossover study	Very serious limitations[5]	Serious indirectness[6]	Not applicable	Not calculable	6	N/a	4 of 6 participants (66.7%) experienced at least 1 temporary failure of the myoelectric multi-grip prosthetic over the 6-month study period. No further detail reported	Important	Very low

Luchetti et al 2015									

Abbreviations: ABIS: Amputee Body Image Scale, ARAT: Action Research Arm Test, BBT: Box and Block Test, CPRT: Clothespin-relocation test, DASH: Disabilities of the Arm, Shoulder and Hand, EURO-QoL EQ-5D: EURO Quality of Life Questionnaire 5 Dimensions, HADS: Hospital Anxiety and Depression Scale, MMDT: Minnesota Manual Dexterity Test, OPUS-CSD: Orthotics and Prosthetics User Survey Client Satisfaction with Devices Scale; OPUS-UEFS: Orthotics and Prosthetics User Survey-Upper Extremity Functional Status, SHAP: Southampton Hand Assessment Procedure, T-MAP: Timed Measure of Activity Performance, TAPES-SAT: Trinity Amputation and Prosthesis Experience Scales Satisfaction Scale

1 Risk of bias: serious limitations due to lack of multiple measurement points for the outcomes
2 Risk of bias: very serious limitations due to lack of detail about study setting and lack of adjustment for potential confounding factors
3 Risk of bias: very serious limitations due to lack of multiple measurement points for the outcomes and lack of any statistical analysis
4 Risk of bias: very serious limitations due to reliance on self-reported survey data and lack of adjustment for potential confounding factors
5 Risk of bias: very serious limitations due to non-reporting of outcome for the comparator arm and lack of any statistical analysis
6 Indirectness: serious indirectness due to no comparison across treatment arms

Table 2: Myoelectric control multi-grip prosthetics vs combinations of single grip prosthetics

QUALITY					Summary of findings			IMPORTANCE	CERTAINTY
					No of patients		Effect		
Study	**Risk of bias**	**Indirectness**	**Inconsistency**	**Imprecision**	**Myoelectric multi-grip prosthetics**	**Single grip prosthetics**	**Result**		
Functional outcome measures (1 cross-sectional study)									
BBT mean (SD) for transradial amputees[A] (single timepoint) (benefit indicated by a higher result)[B]									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	19	68	Myoelectric multi-grip: 15.4 (6.0) Myoelectric single grip (n=15): 15.1 (9.1) Body powered single grip (n=53): 20.6 (9.2) Comparison across the 3 prosthetic types: p=0.02	Critical	Very low
BBT mean (SD) for transhumeral amputees (single timepoint) (benefit indicated by a higher result)[B]									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	5	30	Myoelectric multi-grip: 7.6 (6.5) Myoelectric single grip (n=10): 5.2 (5.7) Body powered single grip (n=20): 11.8 (9.8) Comparison across the 3 prosthetic types: p=0.21	Critical	Very low

Nine Hole Peg Test mean (SD) items per second for transradial amputees (single timepoint) (benefit indicated by a higher result)[B]									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	19	68	Myoelectric multi-grip: 0.01 (0.01) Myoelectric single grip (n=15): 0.06 (0.06) Body powered single grip (n=53): 0.07 (0.06) Comparison across the 3 prosthetic types: p=0.0001	Critical	Very low
Nine Hole Peg Test mean (SD) items per second for transhumeral amputees (single timepoint) (benefit indicated by a higher result)[B]									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	5	30	Myoelectric multi-grip: 0.00 (0.00) Myoelectric single grip (n=10): 0.01 (0.03) Body powered single grip (n=20): 0.05 (0.06) Comparison across the 3 prosthetic types: p=0.031[C]	Critical	Very low
SHAP index of functionality mean (SD) for transradial amputees (single timepoint) (benefit indicated by a higher result)[B]									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	19	68	Myoelectric multi-grip: 39.6 (14.8) Myoelectric single grip (n=15): 41.0 (21.1) Body powered single grip (n=53): 44.0 (19.6) Comparison across the 3 prosthetic types: p=0.57	Critical	Very low
SHAP index of functionality mean (SD) for transhumeral amputees (single timepoint) (benefit indicated by a higher result)[B]									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	5	30	Myoelectric multi-grip: 12.8 (12.7) Myoelectric single grip (n=10): 10.8 (16.6) Body powered single grip (n=20): 14.4 (15.3) Comparison across the 3 prosthetic types: p=0.67	Critical	Very low
QuickDASH mean (SD) for transradial amputees (single timepoint) (benefit indicated by a lower result)									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	18	57	Myoelectric multi-grip: 26.3 (18.1) Myoelectric single grip (n=12): 30.9 (15.8) Body powered single grip (n=45): 29.2 (19.4) Comparison across the 3 prosthetic types: p=0.72	Critical	Very low

QuickDASH mean (SD) for transhumeral amputees (single timepoint) (benefit indicated by a lower result)									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	5	27	Myoelectric multi-grip: 30.5 (13.3) Myoelectric single grip (n=9): 28.2 (13.8) Body powered single grip (n=18): 34.0 (20.7) Comparison across the 3 prosthetic types: p=0.85	Critical	Very low
Activities of daily living (1 cross-sectional survey)									
AM-ULA mean (SD) for transradial amputees (single timepoint) (benefit indicated by a higher result)									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	18	57	Myoelectric multi-grip: 16.4 (6.5) Myoelectric single grip (n=12): 14.9 (7.7) Body powered single grip (n=45): 14.9 (5.3) Comparison across the 3 prosthetic types: p=0.68	Critical	Very low
AM-ULA mean (SD) for transhumeral amputees (single timepoint) (benefit indicated by a higher result)									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	5	27	Myoelectric multi-grip: 11.9 (1.8) Myoelectric single grip (n=9): 9.4 (4.2) Body powered single grip (n=18): 12.3 (6.2) Comparison across the 3 prosthetic types: p=0.23	Critical	Very low
BAM-ULA mean (SD) for transradial amputees (single timepoint) (benefit indicated by a higher result)									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	18	57	Myoelectric multi-grip: 8.0 (1.6) Myoelectric single grip (n=12): 9.2 (1.0) Body powered single grip (n=45): 6.6 (2.1) Comparison across the 3 prosthetic types: p=0.002	Critical	Very low
BAM-ULA mean (SD) for transhumeral amputees (single timepoint) (benefit indicated by a higher result)									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	5	27	Myoelectric multi-grip: 3.5 (0.7) Myoelectric single grip (n=9): 4.0 (not stated) Body powered single grip (n=18): 4.5 (3.4) Comparison across the 3 prosthetic types: p=0.83	Critical	Very low

T-map mean (SD) for transradial amputees (single timepoint) (benefit indicated by a lower result)									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	18	57	Myoelectric multi-grip: 3.9 (0.9) Myoelectric single grip (n=12): 3.9 (0.6) Body powered single grip (n=45): 5.0 (1.8) Comparison across the 3 prosthetic types: p=0.081	Critical	Very low
T-map mean (SD) for transhumeral amputees (single timepoint) (benefit indicated by a lower result)									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	5	27	Myoelectric multi-grip: 7.4 (3.0) Myoelectric single grip (n=9): 4.9 (1.2) Body powered single grip (n=18): 4.6 (1.7) Comparison across the 3 prosthetic types: p=0.18	Critical	Very low
Percentage of transradial amputees needing help with daily activities (single timepoint)									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	18	57	Myoelectric multi-grip: 2/18 (16.7%) Myoelectric single grip: 3/12 (37.5%) Body powered single grip: 7/45 (21.2%) Comparison across the 3 prosthetic types: p=0.57	Critical	Very low
Percentage of transhumeral amputees needing help with daily activities (single timepoint)									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	5	27	Myoelectric multi-grip: 1/5 (20%) Myoelectric single grip: 2/9 (28.6%) Body powered single grip: 3/18 (25%) Comparison across the 3 prosthetic types: p=1.0	Critical	Very low
Quality of life (1 cross-sectional study)									
VR-12 mental component summary mean (SD) for transradial amputees (single timepoint) (benefit indicated by a higher result)									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	18	57	Myoelectric multi-grip: 52.4 (11.5) Myoelectric single grip (n=12): 46.3 (12.8) Body powered single grip (n=45): 53.5 (10.1) Comparison across the 3 prosthetic types: p=0.085	Critical	Very low

VR-12 mental component summary mean (SD) for transhumeral amputees (single timepoint) (benefit indicated by a higher result)									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	5	27	Myoelectric multi-grip: 52.9 (9.4) Myoelectric single grip (n=9): 50.6 (14.6) Body powered single grip (n=18): 50.4 (13.1) Comparison across the 3 prosthetic types: p=0.98	Critical	Very low
VR-12 physical component summary mean (SD) for transradial amputees (single timepoint) (benefit indicated by a higher result)									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	18	57	Myoelectric multi-grip: 41.1 (8.2) Myoelectric single grip (n=12): 43.2 (6.9) Body powered single grip (n=45): 37.5 (8.9) Comparison across the 3 prosthetic types: p=0.085	Critical	Very low
VR-12 physical component summary mean (SD) for transhumeral amputees (single timepoint) (benefit indicated by a higher result)									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	5	27	Myoelectric multi-grip: 44.0 (8.1) Myoelectric single grip (n=9): 41.9 (5.6) Body powered single grip (n=18): 34.7 (13.2) Comparison across the 3 prosthetic types: p=0.17	Critical	Very low
Prosthetic abandonment (1 longitudinal survey)									
Percentage of respondents using a different prosthetic at 12-months follow-up									
1 longitudinal survey Resnik et al 2020a	Very serious limitations[2]	No serious indirectness	Not applicable	Not calculable	33	262	No comparison between groups: Myoelectric multi-grip: 58% Myoelectric single grip (powered hook) (n=14): 43% Myoelectric single grip (Sensor speed) (n=10): 40% Myoelectric single grip (Greifer) (n=6): 67% Body powered single grip (hook) (n=232): 20%	Important	Very low
Patient satisfaction and prosthetic acceptability (1 cross-sectional study, 1 cross-sectional survey)									
TAPES-SAT mean (SD) for transradial amputees (single timepoint) (benefit indicated by a higher result)									
1 cross-sectional study	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	18	57	Myoelectric Multi-grip: 3.8 (0.7) Myoelectric single grip (n=12): 3.5 (0.7)	Important	Very low

Resnik et al 2020b							Body powered single grip (n=45): 4.0 (0.7) Comparison across the 3 prosthetic types: p=0.051		
TAPES-SAT mean (SD) for transhumeral amputees (single timepoint) (benefit indicated by a higher result)									
1 cross-sectional study Resnik et al 2020b	Very serious limitations[1]	No serious indirectness	Not applicable	Not calculable	5	27	Myoelectric multi-grip: 3.7 (0.5) Myoelectric single grip (n=9): 3.5 (0.5) Body powered single grip (n=18): 3.7 (0.9) Comparison across the 3 prosthetic types: p=0.64	Important	Very low
TAPES-SAT assessed by bi-variate linear regression modelling (single timepoint)									
1 cross-sectional survey Resnik et al 2020d	Very serious limitations[3]	No serious indirectness	Not applicable	Not calculable	40	364	Myoelectric multi-grip vs any single grip (myoelectric or body powered) (β -0.07, CI not reported) (p=0.5286)	Important	Very low
OPUS-CSD assessed by bi-variate linear regression modelling (single timepoint)									
1 cross-sectional survey Resnik et al 2020d	Very serious limitations[3]	No serious indirectness	Not applicable	Not calculable	40	364	Myoelectric multi-grip vs any single grip (myoelectric or body powered) (β 1.58, CI not reported) (p=0.6043)	Important	Very low

Abbreviations: AM-ULA: Activities Measure for Upper Limb Amputation, BAM-ULA: Brief Activities Measure for Upper Limb Amputation, BBT: Box and Block Test, CI: confidence interval, QuickDASH: Quick Disabilities of the Arm, Shoulder and Hand, SD: standard deviation, SHAP: Southampton Hand Assessment Procedure, T-MAP: Timed Measure of Activity Performance, TAPES-SAT: Trinity Amputation and Prosthesis Experience Scales Satisfaction Scale, VR-12: Veterans 12-item Health Survey

1 Risk of bias: very serious limitations due to lack of detail about study setting, lack of adjustment for potential confounding factors and lack of statistical analysis comparing individual prosthetic types
2 Risk of bias: very serious limitations due to lack of detail about study population, lack of adjustment for potential confounding factors, reliance on self-reported survey data and lack of any statistical analysis
3 Risk of bias: very serious limitations due to reliance on self-reported survey data and lack of adjustment for potential confounding factors

A Results were only reported separately for transradial and transhumeral amputees for all outcomes reported by Resnik et al 2020b
B This outcome was reported both for unilateral and bilateral amputees combined and for unilateral amputees alone by the study authors. These results are for the unilateral and bilateral amputees together. Results for the unilateral amputees alone are considered a subgroup of the whole population and are not included in the GRADE table
C This result was statistically significant at a p<0.05, but no longer significant after controlling for multiple comparisons

Table 3: Myoelectric control multi-grip prosthetics vs body powered single grip prosthetics

QUALITY					Summary of findings			IMPORTANCE	CERTAINTY
					No of patients		Effect		
Study	Risk of bias	Indirectness	Inconsistency	Imprecision	Myoelectric multi-grip prosthetics	Body powered single grip prosthetics	Result		
Functional outcome measures (1 cross-sectional survey)									
QuickDASH multi-variate linear regression modelling (single timepoint)									
1 cross-sectional survey Resnik et al 2020c	Serious limitations[1]	No serious indirectness	Not applicable	Not calculable	40	325	Myoelectric multi-grip vs body powered single grip (β 1.24, 95%CI -5.88 to 8.36) (p=0.7326)	Critical	Very low
Activities of daily living (1 cross-sectional survey)									
Help needed with daily activities multi-variate logistic modelling (single timepoint) (benefit indicated by a lower result)									
1 cross-sectional survey Resnik et al 2020c	Serious limitations[1]	No serious indirectness	Not applicable	Not calculable	40	325	Myoelectric multi-grip vs body powered single grip (OR 1.75, 95%CI 0.81 to 3.79, p=0.1577)	Critical	Very low
Quality of life (1 cross-sectional survey)									
VR-12 mental component summary multi-variate linear regression modelling (single timepoint)									
1 cross-sectional survey Resnik et al 2020c	Serious limitations[1]	No serious indirectness	Not applicable	Not calculable	40	325	Myoelectric multi-grip vs body powered single grip (β 2.59, 95%CI -2.14 to 7.32) (p=0.2825)	Critical	Very low
VR-12 physical component summary assessed by multi-variate linear regression modelling (single timepoint)									
1 cross-sectional survey Resnik et al 2020c	Serious limitations[1]	No serious indirectness	Not applicable	Not calculable	40	325	Myoelectric multi-grip vs body powered single grip (β -0.97, 95%CI -3.99 to 2.05) (p=0.5295)	Critical	Very low

Abbreviations: CI: confidence interval, OR: odds ratio, QuickDASH: Quick Disabilities of the Arm, Shoulder and Hand, VR-12: Veterans 12-item Health Survey

1 Risk of bias: serious limitations due to reliance on self-reported survey data

Table 4: Myoelectric control multi-grip prosthetic vs no prosthetic use

QUALITY					Summary of findings			IMPORTANCE	CERTAINTY
					No of patients		Effect		
Study	**Risk of bias**	**Indirectness**	**Inconsistency**	**Imprecision**	**Myoelectric multi-grip prosthetic**	**No prosthetic use**	**Result**		
Functional outcome measures (1 cross-sectional survey)									
QuickDASH two-handed (self-reported) tasks mean (±SD) (single timepoint) (benefit indicated by a lower result)									
1 cross-sectional survey Resnik et al 2020c	Serious limitations[1]	No serious indirectness	Not applicable	Not calculable	40	40	Lift and carry bulky objects: 2.8±1.3 vs 2.7±1.1, p=0.67 Spread peanut butter: 3.1±1.4 vs 3.3±1.3, p=0.60 Do housework: 2.5±1.1 vs 2.8±1.2, p=0.12	Critical	Very low
QuickDASH one-handed (self-reported) tasks[A] mean (±SD) (single timepoint) (benefit indicated by a lower result)									
1 cross-sectional survey Resnik et al 2020c	Serious limitations[1]	No serious indirectness	Not applicable	Not calculable	40	40	Pick up small objects: 3.5±1.1 vs 4.5±1.1, p=0.0008 Grasp rounded objects: 2.6±1.2 vs 4.1±1.2, p<0.0001	Critical	Very low

Abbreviations: QuickDASH: Quick Disabilities of the Arm, Shoulder and Hand, SD: standard deviation

1 Risk of bias: serious limitations due to reliance on self-reported survey data

A Assessed using a prosthetic or the remaining residual limb

Glossary

Baseline	The set of measurements at the beginning of a study (after any initial 'run-in' period with no intervention), with which subsequent results are compared.
Bias	Systematic (as opposed to random) deviation of the results of a study from the 'true' results, which is caused by the way the study is designed or conducted.
Clinical importance	A benefit from treatment that relates to an important outcome such as length of life and is large enough to be important to patients and health professionals.
Confidence interval (CI)	A way of expressing how certain we are about the findings from a study, using statistics. It gives a range of results that is likely to include the 'true' value for the population. A wide confidence interval indicates a lack of certainty about the true effect of the test or treatment - often because a small group of patients has been studied. A narrow confidence interval indicates a more precise estimate (for example, if a large number of patients have been studied).
Crossover study design	A study comparing 2 or more treatments. Once people in the study have completed a course of 1 treatment they are switched to a different treatment.
Cross-sectional study	A 'snapshot' observation of a set of people at 1 time. This type of study (sometimes called a cross-sectional survey) contrasts with a longitudinal study, which follows a set of people over a period of time.
GRADE (Grading of recommendations assessment, development and evaluation)	A systematic and explicit approach to grading the quality of evidence and the strength of recommendations developed by the GRADE working group.
Longitudinal study	A study of the same group of people at different times. This contrasts with a cross-sectional study, which observes a group of people at a point in time.
Minimal clinically important difference	The smallest change in a treatment outcome that people with the condition would identify as important (either beneficial or harmful), and that would lead a person or their clinician to consider a change in treatment.
Objective measure	A measurement that follows a standardised procedure which is less open to subjective interpretation by potentially biased observers and people in the study.
Odds ratio	Compares the odds of something happening in 1 group with the odds of it happening in another. An odds ratio of 1 shows that the odds of the event happening (for example, a person developing a disease or a treatment working) is the same for both groups. An odds ratio of greater than 1 means that the event is more likely in the first group than the second. An odds ratio of less than 1 means that the event is less likely in the first group than in the second group.
PICO (population, intervention, comparison and outcome) framework	A structured approach for developing review questions that divides each question into 4 components: the population (the population being studied); the interventions (what is being done); the comparators (other main treatment options); and the outcomes (measures of how effective the interventions have been).
P-value (p)	The p value is a statistical measure that indicates whether or not an effect is statistically significant. For example, if a study comparing 2 treatments found that 1 seems to be more effective than the other, the p value is the probability of obtaining these results by chance. By

	convention, if the p value is below 0.05 (that is, there is less than a 5% probability that the results occurred by chance), it is considered that there probably is a real difference between treatments. If the p value is 0.001 or less (less than a 0.1% probability that the results occurred by chance), the result is seen as highly significant. If the p value shows that there is likely to be a difference between treatments, the confidence interval describes how big the difference in effect might be.
Standard deviation (SD)	A measure of the spread, scatter or variability of a set of measurements. Usually used with the mean (average) to describe numerical data.
Statistical significance	A statistically significant result is one that is assessed as being likely to be due to a true effect rather than random chance.
Survey	A study in which information is systematically collected from people (usually from a sample within a defined population).

References

Included studies

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