NHS England Evidence Review:

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

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Prepared by Solutions for Public Health on behalf of NHS England Specialised Commissioning

Contents

1. Introduction

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

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). The myoelectric control multi-grip device is the intervention in a separate review.

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 (e.g. body powered or myoelectric) 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.

In addition, the review scope included the identification of possible subgroups of patients within the included studies who might benefit from a non-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 and myoelectric control single-grip devices. Hand, partial hand or digit prosthetics are included

2. Executive summary of the review

No papers assessing the clinical effectiveness, safety or cost effectiveness of non-myoelectric control multi-grip upper limb prosthetics were identified for this review.

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 non-myoelectric control multi-grip upper limb prosthetics compared with standard[2] 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.

Functional outcome measures

No evidence was available for functional outcome measures.

Activities of daily living

No evidence was available for activities of daily living.

Quality of life

No evidence was available for quality of life.

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.

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

Prosthetic abandonment

No evidence was available for prosthetic abandonment.

Patient satisfaction and prosthetic acceptability

No evidence was available for patient satisfaction and prosthetic acceptability.

Device durability

No evidence was available for device durability.

Frequency of replacement and/or re-fitting

No evidence was available for replacement and/or re-fitting.

Research question 2:

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

Important outcomes

Adverse events

No evidence was available for adverse events.

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 non-myoelectric control multi-grip upper limb prosthetics compared with standard upper limb prosthetics or no prosthetic use?

No evidence was identified on the cost effectiveness of non-myoelectric control multi-grip upper limb prosthetics 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 a non-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 a non-myoelectric control multi-grip upper limb prosthetic.

Discussion

No evidence on the clinical effectiveness, safety or cost effectiveness of non-myoelectric control multi-grip upper limb prosthetics was identified.

Searches were conducted on three databases for studies published between 2005 and November 2020. Conference abstracts, non-systematic reviews, narrative reviews, commentaries, letters, editorials, pre-publication prints, guidelines, case reports and resource utilisation studies were not eligible for inclusion.

Conclusion

No evidence was identified that allowed any conclusions to be drawn about the clinical effectiveness, safety or cost effectiveness of non-myoelectric control multi-grip upper limb prosthetics compared with standard upper limb prosthetics or no prosthetic use. Published studies on the effectiveness of non-myoelectric control multi-grip prosthetics are needed.

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 non-myoelectric control multi-grip upper limb prosthetics 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 non-myoelectric control multi-grip upper limb prosthetics compared with standard upper limb prosthetics 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 non-myoelectric control multi-grip upper limb prosthetics compared with standard upper limb prosthetics or no prosthetic use?

4. From the evidence selected, are there any subgroups of patients that may benefit from a non-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.

As no relevant studies were identified, the appendices for data extraction tables, critical appraisal checklists and GRADE profiles were not completed.

4. Summary of included studies

No papers assessing the clinical effectiveness, safety or cost effectiveness of non-myoelectric control multi-grip upper limb prosthetics were identified for this review.

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 non-myoelectric control multi-grip upper limb prosthetics compared with standard[3] upper limb prosthetics or no prosthetic use?

Outcome	Evidence statement
Clinical Effectiveness	
Critical outcomes	
Functional outcome measures **Certainty of evidence:** Not applicable	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. No evidence was identified for this outcome.
Activities of daily living **Certainty of evidence:** Not applicable	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. No evidence was identified for this outcome.
Quality of life **Certainty of evidence:** Not applicable	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. No evidence was identified for this outcome.
Important outcomes	
Prosthetic abandonment **Certainty of evidence:** Not applicable	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. No evidence was identified for this outcome.
Patient satisfaction and prosthetic acceptability **Certainty of evidence:** Not applicable	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. No evidence was identified for this outcome.

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

Device durability **Certainty of evidence:** Not applicable	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. No evidence was identified for this outcome.
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 ADL: Activities of daily living	

From the evidence selected, are there any subgroups of patients that may benefit from a non-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 a non-myoelectric control multi-grip upper limb prosthetic.

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

No studies, comparative or non-comparative, were identified about the clinical effectiveness, safety or cost effectiveness of non-myoelectric control multi-grip upper limb prosthetics compared with standard upper limb prosthetics or no prosthetic use. This lack of evidence applies to both non-myoelectric control multi-grip hands and non-myoelectric control multi-grip partial hand and digit devices.

Searches were conducted on three databases for studies published between 2005 and November 2020. Conference abstracts, non-systematic reviews, narrative reviews, commentaries, letters, editorials, pre-publication prints, guidelines, case reports and resource utilisation studies were not eligible for inclusion.

7. Conclusion

No evidence was identified that allowed any conclusions to be drawn about the clinical effectiveness, safety or cost effectiveness of non-myoelectric control multi-grip upper limb prosthetics compared with standard upper limb prosthetics or no prosthetic use. Published studies on the effectiveness of non-myoelectric control multi-grip prosthetics are needed.

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 non-myoelectric control multi-grip upper limb prosthetics compared with standard[4] 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 non-myoelectric control multi-grip upper limb prosthetics compared with standard upper limb prosthetics 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 non-myoelectric control multi-grip upper limb prosthetics compared with standard upper limb prosthetics or no prosthetic use?

4. From the evidence selected, are there any subgroups of patients that may benefit from a non-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 [Above elbow amputation could be defined as elbow disarticulation, transhumeral, shoulder disarticulation and forequarter amputation. Below elbow amputation could be defined as transradial, wrist disarticulation, transcarpal or partial hand and finger absence.] [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	Non-myoelectric control multi-grip upper limb prosthetics that are commercially available in UK settings including: • **Non-myoelectric control multi-grip hand devices**

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

	• **Non-myoelectric control multi-grip partial hand and digit devices** [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)] [Brand names and manufacturers are: ”X” finger and “X” hand prosthetics (Didrick Medical). “GripLock Finger”, “MCPDriver”, “PIPDriver” and “ThumbDriver” (Naked Prosthetics)] [Devices which are not commercially available in UK setting/only available in research trial settings should be excluded]
C-Comparator	Standard upper limb prosthetics without non-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. • 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] [Myoelectric controlled prosthetics are powered by an external battery power source. The single-grip myoelectric control device allows a single axis of movement, where the thumb and digits are not independent of each other. The myoelectric control multi-grip device is the intervention in a separate review]
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)[5]; Southampton Hand Assessment Profile (SHAPS); Trinity Amputation and Prosthesis Experience Scales (TAPES); Assessment of Capacity for Myoelectric Control (ACMC); Canadian Occupational Performance Measure (COPM))[6] 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) *Important to decision-making:* • **Prosthetic abandonment**

[5]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)

[6]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)

	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[7]:

1 Artificial Limbs/

2 (prosthes?s or prosthetic? or artificial limb? or bionic limb?).ti.

3 1 or 2

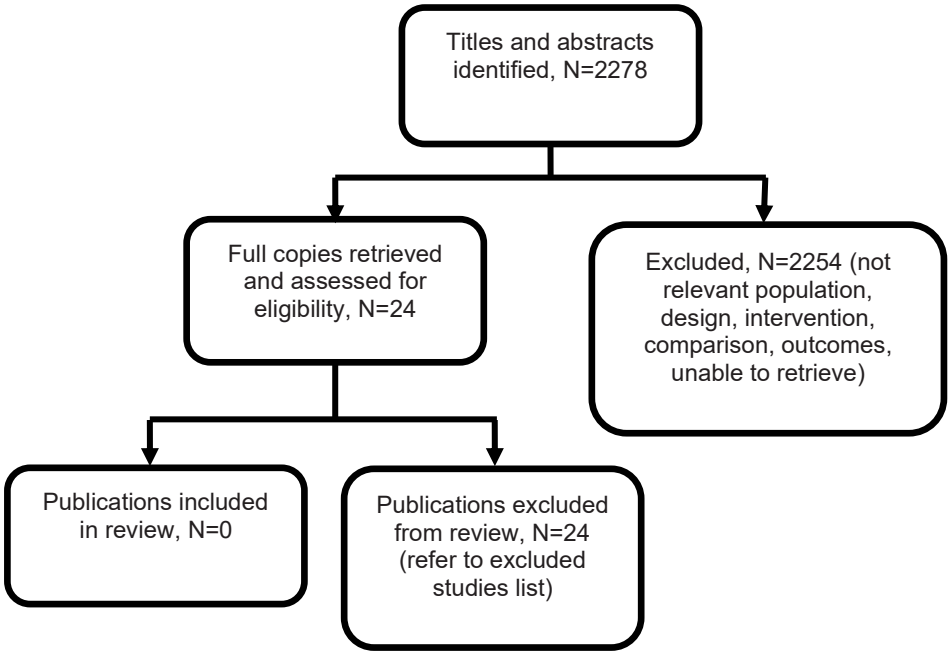
[7] This second, supplemental search for key authors (those with multiple publications) was conducted as an additional check for any potentially relevant papers

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")

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 24 references relating to either non-myoelectric control prosthetics or both types of prosthetics were obtained in full text and assessed for relevance. Of these, 0 references are included in this evidence review. The 24 references excluded are listed in Appendix D. References relating to 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 non-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
Arazpour M, Mardani MA, Bahramizadeh M, Layeghi F, Zarezadeh F, Curran S. The effect of new method of suspension on quality of life, satisfaction, and suspension in patients with finger prostheses. Prosthetics and orthotics international. 2015;39(3):197?203.	Not assessing a multi-grip prosthetic
Berning K, Cohick S, Johnson R, Miller LA, Sensinger JW. Comparison of body-powered voluntary opening and voluntary closing prehensor for activities of daily life. Journal of Rehabilitation Research & Development. 2014;51(2):253-61.	Not assessing a multi-grip prosthetic
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
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 non-myoelectric multi-grip prosthetics. Any individual studies potentially in scope considered separately
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
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 non-myoelectric multi-grip prosthetics. Any individual studies potentially in scope considered separately
Hashim NA, Abd Razak NA, Abu Osman NA, Gholizadeh H. Improvement on upper limb body-powered prostheses (1921-2016): A systematic review. Proceedings of the Institution of Mechanical Engineers Part H - Journal of Engineering in Medicine. 2018;232(1):3-11.	Broad review of studies about various prosthetics. No separate results for non-myoelectric multi-grip prosthetics. Any individual studies potentially in scope considered separately
Hashim NA, Abd Razak NAB, Gholizadeh H, Osman NAA. Analysis of voluntary opening Ottobock Hook and Hosmer Hook for upper limb prosthetics: a preliminary study. Biomedizinische Technik. 2017;62(4):447-54.	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 prosthetic. No outcomes reported by type of 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
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 prosthetic. 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

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
Resnik L, Borgia M, Biester S, Clark MA. Longitudinal study of prosthesis use in veterans with upper limb amputation. Prosthetics & Orthotics International. 2020:309364620957920.	No results for non-myoelectric multi-grip prosthetics. Study included in the myoelectric multi-grip review
Resnik L, Borgia M, Cancio J, Heckman J, Highsmith J, Levy C, et al. Dexterity, activity performance, disability, quality of life, and independence in upper limb Veteran prosthesis users: a normative study. Disability & Rehabilitation. 2020:1-12.	No results for non-myoelectric multi-grip prosthetics. Study included in the myoelectric multi-grip review
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 & Rehabilitation. 2020;101(8):1396-406.	No results for non-myoelectric multi-grip prosthetics. Study included in the myoelectric multi-grip review
Resnik L, Borgia M, Heinemann AW, Clark MA. Prosthesis satisfaction in a national sample of Veterans with upper limb amputation. Prosthetics & Orthotics International. 2020;44(2):81-91.	No results for non-myoelectric multi-grip prosthetics. Study included in the myoelectric multi-grip review
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 non-myoelectric multi-grip prosthetics. Any individual studies potentially in scope considered separately
Salminger S, Vujaklija I, Sturma A, Hasenoehrl T, Roche AD, Mayer JA, et al. Functional Outcome Scores With Standard Myoelectric Prostheses in Below-Elbow Amputees. American Journal of Physical Medicine & Rehabilitation. 2019;98(2):125-9.	No results for non-myoelectric multi-grip prosthetics. Study included in the myoelectric multi-grip review
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
Valevicius AM, Boser QA, Chapman CS, Pilarski PM, Vette AH, Hebert JS. Compensatory strategies of body-powered prosthesis users reveal primary reliance on trunk motion and relation to skill level. Clinical Biomechanics. 2020;72:122-9.	Not assessing a multi-grip prosthetic

Appendix E Evidence Table

No papers assessing the clinical effectiveness, safety or cost effectiveness of non-myoelectric control multi-grip upper limb prosthetics were identified for this review.

Appendix F Quality appraisal checklists

No checklists were used in this review.

Appendix G GRADE profiles

No papers assessing the clinical effectiveness, safety or cost effectiveness of non-myoelectric control multi-grip upper limb prosthetics were identified for this review.

Glossary

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.
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).

References

Included studies

No studies were identified for inclusion.

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