Low-Resource Environmental Facilitators to Participation in Sport and Physical Activity for Australians Living with Limb Loss: A Retrospective Thematic Analysis

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Abstract

A gap in the knowledge exists regarding facilitators to sport and physical activity (PA) participation among Australians with limb loss (LL). This study aimed to address this gap by exploring low-resource environmental facilitators to sport and PA participation and examining activity preferences requiring low individual resources. Australians living with LL (n=111) completed an online survey distributed by Limbs 4 Life Australia. Reflexive thematic analysis was used to analyse qualitative responses. These were subsequently classified according to perceived resource requirements to identify facilitators and activities that may be more readily addressed. Two low-resource environmental facilitator themes relating to equipment and prostheses were identified. Participants also reported interest in a diverse range of activities, with 63% of activities classified as requiring low individual resources. These findings highlight practical facilitators that may support participation and inform future interventions and policy development for Australians living with LL.

Key words: amputation, prosthesis, adaptive equipment, para-sport

Introduction

The Paralympic Games have played an important role in highlighting the capabilities of individuals with limb loss (LL) and in shaping societal perceptions surrounding disability and participation in physical activity (PA) and sport. As Australia prepares to host the Brisbane 2032 Paralympic Games, increasing attention is being placed on disability inclusion, accessibility and equitable opportunities for participation in sporting and recreational activities within Australian communities (Paralympics Australia, 2025). As para-sport continues to advance inclusion, challenge stigma and improve access to physical education, disability-specific participation data is needed to better understand the needs and challenges faced by individuals living with disability and to inform future policy and practice

(International Paralympic Committee, 2025). In Queensland, this is reflected in the Empower Project, a Brisbane 2032 initiative aimed at increasing sport and recreation participation among people with disability, including through the development of a data collection framework to better understand participation experiences (Queenslanders with Disability Network, n.d.).

Limb loss, commonly referred to as amputation, is the loss of part or all of a limb and is a significant contributor to physical disability worldwide (Bernatchez et al., 2021; Limbs 4 Life, n.d.). In Australia, approximately 8,000 amputations are performed annually, with diabetes mellitus, peripheral artery disease, trauma and malignant tumours among the most common causes (Dillon et al., 2017; Lazzarini et al., 2012). The prevalence of Australians living with LL is projected to grow by 2.7% annually, resulting in approximately 259,000 healthy years of life lost and costing an estimated $33 billion between 2020 and 2050 (KPMG, 2021). Individuals living with LL also frequently experience comorbid conditions, including cardiovascular disease, diabetes mellitus, chronic pain and renal dysfunction, and have overall reduced physical function (Amtmann et al., 2015; Stern et al., 2017). Beyond physical consequences, LL is associated with poorer mental health outcomes including depression, anxiety, reduced social participation and reduced quality of life (Jo et al., 2021). These physical and psychological challenges contribute to increased morbidity and mortality for individuals with LL (Stern et al., 2017).

Greater engagement in an active lifestyle may help address these health and socioeconomic burdens, with PA widely recognised for its physical, psychological and social benefits for individuals living with LL. Regular participation in PA is associated with an inverse dose-response relationship with all-cause mortality and reduces the risk of numerous chronic health conditions (Reiner et al., 2013; Warburton et al., 2006). PA also contributes to improved cardiopulmonary fitness, psychological well-being, social reintegration, physical functioning

and overall quality of life (Bouzas et al., 2021; Bragaru et al., 2011; Warburton et al., 2006). Despite these recognised benefits, 61% of Australians with LL have insufficient PA levels to support health, with 33% classified as sedentary, suggesting that this population continues to experience unique and complex challenges that limit participation (Langford et al., 2019; Pepin et al., 2018).

Given low participation levels among individuals with LL, understanding the facilitators to participation is essential for informing targeted programs, interventions and policy changes. Previous research has consistently identified a range of factors that facilitate participation, which can be broadly categorised as personal and environmental (Bragaru et al., 2013; Kerfeld et al., 2018; Littman et al., 2014; Littman et al., 2017; Meulenbelt et al., 2011; Olsen et al., 2023; Sayed Ahmed et al., 2018; Toovey et al., 2025). Personal facilitators, referring to factors internal to the individual, include greater physical fitness, confidence, previous PA experience and positive self-perceptions (Bragaru et al., 2013; Littman et al., 2017; Sayed Ahmed et al., 2018; Toovey et al., 2025). Environmental facilitators include factors external to the individual, such as appropriate prosthesis fit and function, adaptive equipment, inclusive communities, accessible environments and funding (Kerfeld et al., 2018; Littman et al., 2014; Meulenbelt et al., 2011; Olsen et al., 2023; Sayed Ahmed et al., 2018; Toovey et al., 2025).

Although previous research has provided valuable insights into facilitators to PA and sport participation among the LL population, the existing evidence base remains limited. Much of the literature consists of cross-sectional and descriptive qualitative studies that are limited by small sample sizes and reliance on self-reported data, introducing potential bias including recall error, social desirability bias and selection bias (Bragaru et al., 2013; Kerfeld et al., 2018; Littman et al., 2017; Olsen et al., 2023; Sayed Ahmed et al., 2018; Toovey et al., 2025). Many studies have focused on specific subpopulations, amputation levels or geographic regions, limiting the representativeness and generalisability of findings to the broader LL

community (Bragaru et al., 2013; Kerfeld et al., 2018; Littman et al., 2017; Meulenbelt et al., 2011; Olsen et al., 2023; Sayed Ahmed et al., 2018; Toovey et al., 2025). There is also a notable lack of Australian-specific research, limiting the applicability of findings to the Australian context where healthcare systems, environmental conditions and social factors may influence participation differently. Furthermore, although previous studies have identified facilitators that may inform future interventions, the relative resources required to address or implement these facilitators have not been examined. Consequently, it remains unclear which may be more readily addressed, and which require broader system-level or policy changes. Collectively, these limitations reduce the transferability of findings and restrict the development of targeted, evidence-based programs or policies that effectively address the needs of Australians living with LL.

Work to Date

In 2024, Limbs 4 Life (L4L) developed and distributed an ad hoc survey exploring barriers, facilitators and activity preferences to sport and PA participation among Australians living with LL. The survey was designed to better understand the experiences of the Australian LL community to inform future research, programs and initiatives aimed at improving participation opportunities. The survey was also intended to inform the development of a standardised and validated tool that could be applied across wider populations to further understanding of barriers and facilitators to participation.

As part of the initial development of this study, qualitative responses relating to barriers to participation and activity preferences were explored by two Honours students in 2025. Their findings highlighted a range of barriers that limit participation such as inadequate functioning or fitting prostheses, fear of participation or falling and limited transport and support. These barriers were classified broadly into intrinsic and extrinsic factors; however, following further review of the literature, these categories have been reframed as personal and environmental

factors. This change in terminology has been adopted throughout the present study, while maintaining the underlying concepts identified in the previous analyses.

Aim & Research Questions

The overall goal of this study was to identify and explore the facilitators to sport and PA participation among Australians living with LL. To address this goal, two specific aims were established. The first aim was to explore environmental facilitators according to their level of resources, particularly those requiring relatively low resources. The second aim was to contextualise the facilitators by exploring reported activity preferences, particularly those requiring low individual resources to participate in. High-resource facilitators and activities requiring high infrastructure or individual resources were beyond the scope of this study and are explored in a complementary analysis.

Accordingly, this study was articulated around the following research questions:

1. What are the reported facilitators that enhance participation in sport and PA among Australians living with LL?
2. What are the reported environmental factors enabling participation to sport and PA that are likely to require low resources?
3. What are the potential sports and PA preferences that are likely to require low individual resources?

In the context of this study, resource requirements for facilitators were considered from an implementation perspective. For example, although a prosthesis may involve substantial out-of-pocket costs for an individual, improving prosthetic access or provision was considered to require relatively lower resources than implementing large-scale infrastructure or policy changes.

Method

Study Design

This study utilised retrospective thematic analysis of qualitative data obtained from a cross-sectional survey of Australians living with LL. Due to its flexibility and suitability, Braun and Clarke's six-phase framework was selected to explore participant experiences and perceived facilitators to sport and PA participation (Ahmed et al., 2025). This approach allowed the research team, comprising Kelsey Woolley, Phoebe Ellem, Laurent Frossard and Tania Brancato Best, to engage in an iterative coding process and apply interpretive judgement throughout analysis, enabling themes to be continually refined and reorganised as patterns of shared meaning became apparent. The flexible nature of this reflexive thematic analysis enabled a deeper exploration and understanding of how participants described the role of prosthetic technologies, prosthetic care and adaptive equipment in facilitating participation in sport and PA.

Participants

A total of 111 individuals who responded to the survey were included in this study. Participants were eligible for inclusion if they were living with LL and residing in Australia at the time of survey completion. There were no exclusion criteria relating to age, gender, level or time since amputation, geographical location within Australia or socioeconomic status. Participants were recruited through the social media channels of L4L, a not-for-profit organisation and peak body supporting individuals living with LL in Australia. Recruitment posts containing a link to the online SurveyMonkey survey were published, allowing participants to voluntarily access and complete the survey.

Ethical Considerations

Due to the retrospective nature of this project and the use of de-identified survey responses, the study was considered minimal risk and granted ethics exemption through the Queensland University of Technology Human Research Ethics Committee. All survey responses remained anonymous to the research team to protect participant privacy and confidentiality.

Data Collection

An ad hoc survey was collaboratively developed by project supervisor Prof Laurent Frossard and Melissa Noonan from L4L, with question development guided by their professional expertise and experience within the LL and PA sectors. No existing surveys or external studies were adapted or utilised to inform the question development. Data collection occurred over a three-week period, commencing on the 26th of February 2024 and closing on the 17th of March 2024.

The survey consisted of a combination of open-ended and categorical questions designed to capture exposure, outcome and confounding variables (Appendix A). Specifically, the survey collected:

1. Barriers and facilitators to participation in sport and recreational activities (exposure variables) – through open-ended questions.
2. Sport and recreational activity interests (outcome variable) – through an open-ended question asking participants to list up to five activities they would like to participate in.
3. Demographic information (confounding variables) – four categorical questions capturing location, gender, age and level of amputation.

Following completion of data collection by L4L, responses received through SurveyMonkey were de-identified prior to being provided to the research team in Microsoft Excel

spreadsheets. Responses for each survey question were organised into separate spreadsheet tabs to assist with data analysis and coding. Multiple spreadsheet versions were maintained throughout analysis to document coding changes, theme refinement and reflexive analytical decisions.

Data Analysis

Facilitators

A reflexive thematic analysis was conducted for qualitative responses relating to facilitators to sport and PA participation following Braun and Clarke's six-phase framework (Ahmed et al., 2025). Firstly, Woolley and Ellem independently reviewed responses to the open-ended survey question, "If you had a magic wand, what item would you have/create that should help you to participate more to recreational or sporting activities?". Responses were read several times to develop familiarity with the facilitator dataset before independently coding responses according to recurring descriptors, concepts and shared ideas relevant to participation in sport and PA. Coding decisions were then collaboratively reviewed and refined by the research team. Coded responses were then organised into preliminary themes and subthemes based on patterns within the data. During this process, overlap between emerging facilitator themes and previously analysed barrier themes from the broader project was identified. This resulted in responses being organised into overarching personal and environmental categories, with further themes developed within each category. Themes and subthemes then underwent ongoing refinement, with several being renamed, repositioned or merged throughout this phase as understanding of the responses evolved through collaborative discussions within the research team. Frequency counts and percentages were calculated relative to the total sample (number of responses = 100%) to summarise the prevalence of identified themes and subthemes. As themes and subthemes were not mutually exclusive, individual responses could be coded into multiple themes and subthemes. Consequently, the combined frequencies of

themes and subthemes could exceed the number of individual responses. A lexicon for facilitator categories, themes and subthemes was developed to support consistent interpretation throughout analysis (Appendix B). Participant quotations and descriptions of themes were subsequently selected for inclusion in the written report to support interpretation and presentation of findings.

Building on this preliminary thematic analysis, the next analysis focused on environmental facilitator themes and subthemes classified according to perceived resource requirements. This process aimed to distinguish facilitators that may be more readily addressed through participant-centred interventions in contrast to those requiring broader system-level interventions. Existing themes and subthemes generated through thematic analysis were retained and subsequently classified as either low-resource or high-resource based on the nature of support, intervention or system-level change required. Classification decisions were informed by first-principles reasoning and collaborative discussion within the research team. Facilitators were subjectively categorised as low-resource when they directly related to individual-level supports (inc. prosthetic adaptation). Conversely, facilitators were subjectively categorised as high resources when they involved broader systemic or infrastructure-related changes.

Sports and Physical Activities

The outcome variable of participant interest in sport and PA was acquired through the survey question: “List the 5 main recreational activities or sporting activities that you would like to participate in”. Responses were tallied to determine the frequency of each reported activity. Using an iterative and reflexive process, initial activity coding and classification were previously undertaken by two Honours students in 2025. Activities were organised into

overarching activity categories before being further classified according to activity characteristics including type, context, adaptation and resource requirements.

As part of the present study, the research team reviewed the existing coding framework and classification outcomes, confirming the overall appropriateness of the established categories and definitions. During this review, refinements to category names and activity classifications were undertaken by Woolley to improve clarity and reduce the proportion of responses previously classified as 'miscellaneous' (59%), which was considered an overly broad category by the research team. Activities were also further classified and coded by Woolley according to both the level of individual and infrastructure resources required to participate (e.g. individual-low, individual-high, infrastructure-low, infrastructure-high). Two independent raters (Ellem and Frossard) reviewed and confirmed the coding decisions were accurate and appropriate. In case of disagreement in coding, a consensus was established using a third independent reviewer through discussion. The lexicon outlining definitions and classification criteria for activity preferences can be found in Appendix C.

Methodological Rigour and Reflexivity

Transparency, researcher reflexivity and methodological rigour were maintained throughout the thematic analysis (Ahmed et al., 2025). Following Braun and Clarke's approach, researcher triangulation was incorporated through independent coding by Woolley and Ellem across multiple iterations, followed by collaborative review and refinement of coding decisions with the supervisory team. Throughout each stage of the analytic process, the research team reflected on how their personal and professional experiences in sport, PA, exercise physiology or LL research may have influenced data interpretation and theme development. This collaborative and reflexive process strengthened the transparency and credibility of the analytic method.

Results

Participant Characteristics

A total of 111 individuals living with LL in Australia completed the survey. The respondents were predominantly male (60%), with the majority aged between 50-69 years (55%). The majority of the participants were adults (95%) with remaining participants aged 19 years or younger. There was geographical distribution across all Australian states and territories, and 95% of participants reported living with a lower-limb amputation. Participant characteristics are summarised in Table 1.

Table 1: Participant Characteristics

Category	Number (N)	Percentage (%)
Gender		
Female	43	39%
Male	65	60%
Transgender	1	1%
Age Categories		
12 or under	4	4%
13-19	2	2%
20-29	2	2%
30-39	6	5%
40-49	9	8%
50-59	31	28%
60-69	30	27%
70-78	22	20%
80+	5	5%

Location		
Australian Capital Territory	4	4%
New South Wales	19	18%
Northern Territory	1	1%
Queensland	10	9%
South Australia	17	16%
Tasmania	5	5%
Victoria	33	31%
Western Australia	17	16%
Level of Amputation		
Lower Limb	105	95%
Upper Limb	5	5%
Upper & Lower Limb	1	1%

Facilitators

101 responses out of the 111 received for the facilitator question were considered valid for analysis following the exclusion of six unclear responses and four non-responses. Responses were initially coded under two overall categories, environmental facilitators and personal facilitators, before being further classified into eight themes and seventeen subthemes. Personal facilitators were reported by 22% (n=24) of participants and comprised two themes and eight subthemes. Environmental facilitators were reported by 77% (n=85) of participants and comprised six themes and nine subthemes.

Although personal-related responses were identified within the dataset, many were determined to be more reflective of underlying barriers than facilitators to participation. These barriers included limitations, physical challenges or LL related concerns. These responses

were coded as “true-false barriers”. Of the 24 personal-related facilitator responses identified, 19 were classified as true-false barriers and were therefore considered more appropriately aligned with personal barriers rather than facilitators to participation. Due to the limited number of ‘true’ personal facilitator responses these were not explored further in the present study. A summary of the personal facilitator themes and subthemes including their frequency can be found in Appendix D.

Environmental facilitators were further classified according to perceived resource requirements. This study focused on the low-resource environmental facilitators, which accounted for 48% of all environmental responses. Within this category, two overarching themes were identified: equipment (12%, n=13), relating to tools or aids excluding prostheses that facilitated participation and prosthesis (36%, n=40), relating to facilitators associated with artificial limbs. Four subthemes were identified across the themes (Table 2), and Figure 1 highlights the prominence of the low-resource facilitator subthemes within the broader environmental facilitators.

Table 2: Main Themes and Subthemes to Low-Resource Environmental Facilitators to Sport and PA Participation

Theme	Subtheme
Equipment	Adapted Equipment
Prosthesis	Fitting & Comfort of Prosthesis
	Reliability & Function of Prosthesis
	Purpose Built Prostheses & Accessories

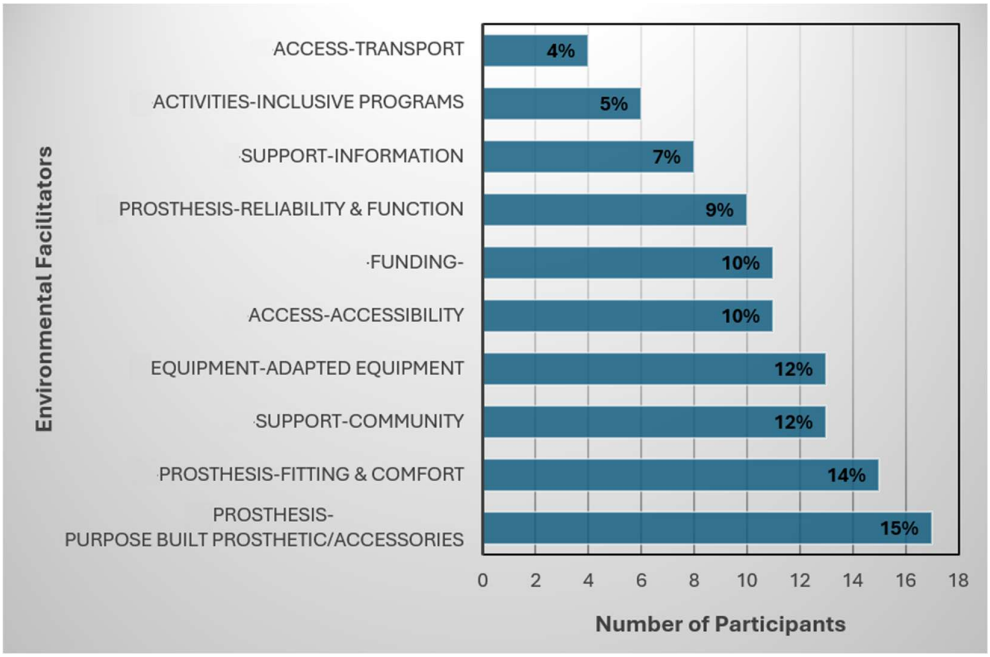

Figure 1: Ranking of Environmental Facilitators to Participation in Sport and PA by Number (n=111) and Percentage of Participants (111=100%)

Main Theme 1: Equipment

Equipment-related facilitators accounted for 12% of participant responses (n=13) and referred to adaptive tools or aids that participants stated would assist participation in sport or PA. The primary subtheme identified within this theme was adapted equipment.

Adapted Equipment

Responses commonly referred to sport-specific equipment, with wheelchairs representing one of the most frequently identified forms of adaptive equipment that would facilitate participation.

> *"A battery electric drag-racing wheelchair so I could race others." (Participant 118546845458)*

> *"A wheelchair that I could use for distance, one that enables me to compete in running events that I could peddle or hand peddle." (Participant 118544353568)*

Participants also highlighted how modifications to gym and sporting equipment may facilitate greater participation by accommodating different amputation levels and improving comfort during exercise.

> *"More adjustments in the leg machines at the gym. They do currently adjust the height of the bar that rests on your shins for extensions, but it doesn't go high enough for me. I would need it to be resting higher on the sockets than the current level of adjustment allows in order for it to not press in places that make the socket painful or tries to pull my legs off." (Participant 118559448357)*

> *"A bike adapted for an above knee amputee." (Participant 118552033086)*

Main Theme 2: Prosthesis

'Prosthesis' was the most common theme, accounting for 36% of participant responses (n=40). This theme was further divided into three subthemes of fitting and comfort of prosthesis, reliability and function of prosthesis and purpose-built prostheses and accessories.

Fitting and Comfort of Prosthesis

Improved fit and comfort of prosthesis was identified by 14% of participants (n=15) as a facilitator to participation. Responses commonly referred to improved socket fit, prosthetic attachment and comfort during movement as factors that would enhance participation in recreational or sporting activities when using their prostheses.

> *"A better way to keep the socket attached to my residual limb" (Participant 118552234905)*

> *"A prosthetic that fits like a second skin, whereby you no longer need to add socks for volume." (Participant 118546623662)*

"Just being able to seal my leg so no water gets into my socket." (Participant 118546322431)

Many respondents specifically emphasised the importance of comfort and pain reduction in supporting participation, particularly in aiding prolonged use with most sporting or recreational activities being generally over 20 minutes in length.

"A comfortable and proper fitting socket!" (Participant 118546074338)

"A socket that would not cause pain after prolonged use." (Participant 118544261960)

Reliability and Function of Prosthesis

Prosthetic reliability and function were identified as important facilitators by 9% of participants (n=10). Responses commonly referred to improved movement, flexibility, durability and overall prosthetic performance during sporting or recreational activities.

"Again, movable ankles. This stops me from doing things. And this Roll later gets in the way…." (Participant 118546101013)

"More flexibility of/within the prosthesis" (Participant 118547354074)

"Break down proof prosthesis!" (Participant 118550939186)

A participant also highlighted the importance of having a reliable and appropriately functioning prosthesis to reduce injury risk and support consistent participation.

"Having the right prosthetic is vital. Sometimes the wait time to trial a new leg/set up, means he will miss a season getting things right so that injuries do not occur affecting everyday mobility. We are still trying to work out the best set up for cross country as the track leg is not a suitable option." (Participant 118546075776)

Purpose-Built Prostheses and Accessories

The most frequently reported subtheme within 'Prosthesis' was 'purpose-built prostheses and accessories', accounting for 15% of participants' responses (n=17). Responses reflected a desire for activity-specific prostheses including those for swimming, running or general exercise.

> *"A wet leg." (Participant 118558518032)*

> *"A waterproof light and buoyant right arm prosthetic for surfing, a better and less painful to use prosthetic tab bat right-handed in cricket and a better prosthetic for bowling and catching right armed in cricket again, as well as a better arm for piano and guitar playing again." (Participant 118547485319)*

Several responses specifically referenced advanced or bionic prosthetic technologies as a means of facilitating participation.

> *"A bionic arm that functions with a brachial plexus injury." (Participant 118547296124)*

> *"A true bionic leg." (Participant 118546073415)*

Participants also reported a range of prosthetic accessories and modifications that may facilitate participation by improving safety, comfort and confidence.

> *"A removable foot that has studs in the sole so that I can have better traction on rough surfaces. My club has a base made of crushed limestone which can be loose underfoot at the best of times." (Participant 118546108666)*

> *"I am a LBK amputee and always worry that the prosthetic I wear will cause others serious damage. So, a soft spongey kind of shell covering could put my mind at ease in protecting others." (Participant 118544291067)*

Activities

Participants reported a broad range of sporting and recreational activity interests, with 424 activity responses recorded across the 111 participants. Following the removal of 11 unclear responses (2.59%), a total of 125 unique activities remained for analysis. The ten most frequently reported activities are presented in Figure 2.

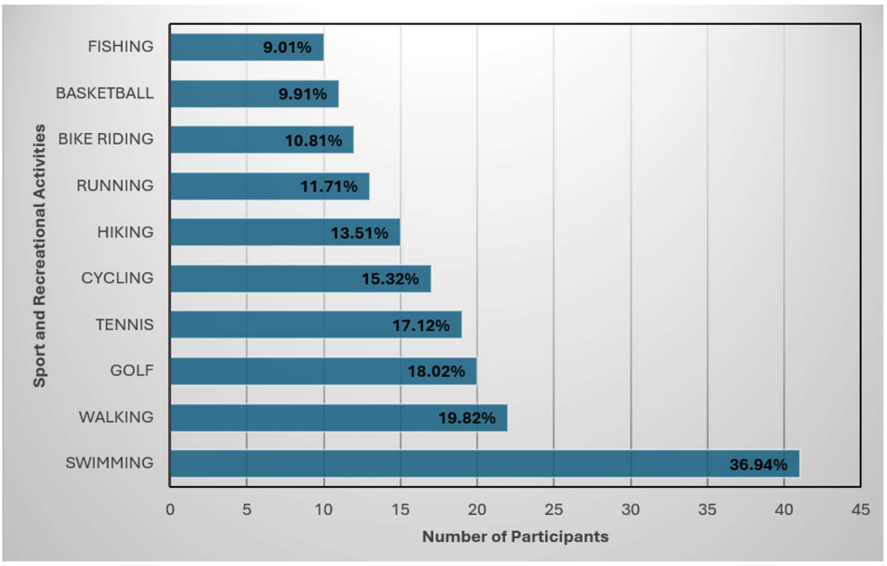

Figure 2: Top 10 Sporting or Recreational Activities Reported by Number (n=111) and Percentage of Participants (111 =100%)

To facilitate interpretation, activities were organised into nine broader categories of Water Sports, Walking, Team Activities, Bike Riding, Gym, Running, Wheelchair, Miscellaneous Sport and Miscellaneous Recreational. The distribution of activity categories is shown in Figure 3.

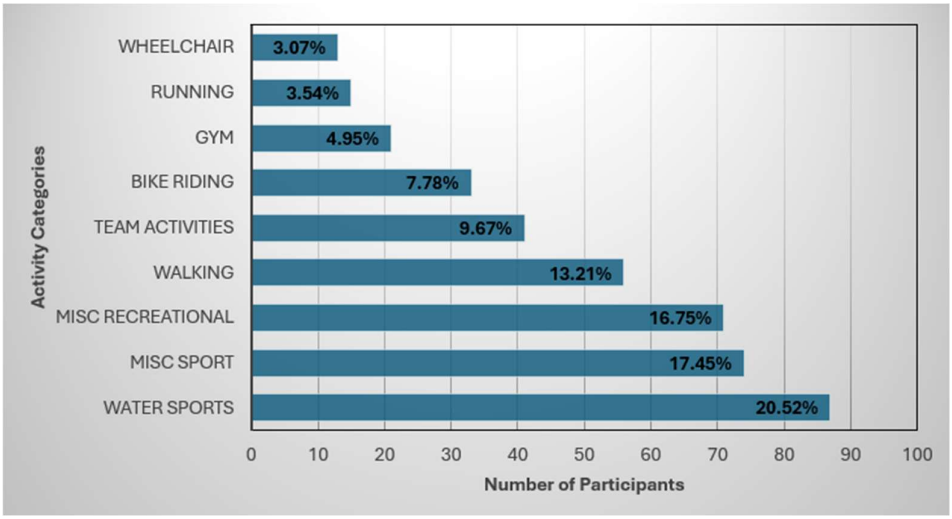

Figure 3: Distribution of Activity Preferences Across the Nine Activity Categories Reported by Number (n=111) and Percentage of Participants (111=100%)

Activity preferences were further categorised according to activity type, social context, setting and adaptation (Table 3). Participants expressed the most interest in recreational (69%), individual (78%), outdoor (78%) and adapted (51%) activities. Overlap existed between categories as some activities could be classified into multiple categories (e.g. activities that can be performed individually or as a part of team), highlighting a diverse range of participation opportunities desired by Australians living with LL.

Table 3: Characteristics of the Preferred Sporting and Recreational Activities

Category	**Number (n)**	**Percentage (%)**
Activities		
Sport	245	58%
Recreational	294	69%
Social Context		
Individual	332	78%
Team	95	22%

Set-Up		
Indoor	153	36%
Outdoor	329	78%
Adaptation		
Mainstream	171	40%
Adapted	215	51%

Activities Requiring Low Individual Resources

Activities were further classified according to the individual resources required to participate in them. Overall, 63% (n = 79) of the unique activities were classified as requiring low individual resources. Figure 4 demonstrates the number and percentage of participants interested in each activity category classified as requiring low individual resources. Percentages do not total 100% as participants could nominate multiple activities they were interested in. No bike riding or wheelchair activities were classified as requiring low individual resources. Notably, all the running, walking, gym and team activities of interest were classified as requiring low individual resources, with none identified as requiring high individual resources.

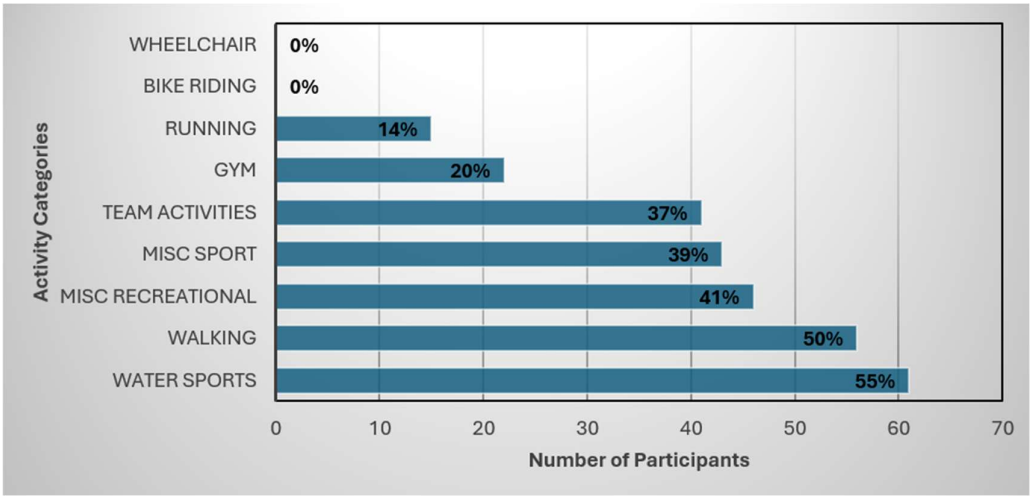

Figure 4: Ranking of Activity Categories per Low Individual Resources by Number (n=111) and Percentage of Participants (111=100%)

Discussion

Key Results

This study explored low-resource environmental facilitators to sport and PA participation among Australians living with LL and examined activity preferences requiring low individual resources. Two overarching low-resource facilitator themes were identified: prosthesis and equipment. Participants also reported interest in a wide range of sporting and recreational activities, the majority of which were classified as requiring low individual resources to enable participation. Altogether these findings suggest that participation could be supported through targeted interventions and service improvements within existing prosthetic and equipment-related supports, providing practical opportunities to facilitate participation without requiring broader system-level change. Furthermore, examining activity preferences alongside facilitators provides practical insight into not only what supports individuals may require, but also the activities these supports may enable.

The findings of this study align closely with previous international literature which has consistently identified the importance of prosthetic factors in supporting sport and PA participation among individuals living with LL (Kerfeld et al., 2018; Meulenbelt et al., 2011; Olsen et al., 2023; Sayed Ahmed et al., 2018; Toovey et al., 2025). These factors include prosthesis fit, comfort, functionality and activity-specific prostheses (Kerfeld et al., 2018; Meulenbelt et al., 2011; Olsen et al., 2023; Sayed Ahmed et al., 2018; Toovey et al., 2025). Similarly, access to adapted equipment and assistive devices were identified as important facilitators for supporting participation which was consistent with qualitative studies conducted in the United States of America and Australia (Littman et al., 2014; Littman et al., 2017; Olsen et al., 2023; Sayed Ahmed et al., 2018; Toovey et al., 2025). The consistency of these findings across international studies suggests that facilitators relating to prosthetic technologies and equipment may reflect common experiences of living with LL, rather than factors distinctive to the Australian LL community. Despite differences in healthcare, community and sporting environments across different countries, the consistency in adaptive equipment and assistive devices supporting participation reinforces that service improvements and policy changes addressing these facilitators may have relevance and applicability across international healthcare and sporting contexts.

A novel contribution of this study was the classification of facilitators according to perceived resource requirements needed to implement or address them. Approximately half of all environmental facilitators were classified as requiring low resources, suggesting that many facilitators to participation may be addressed through relatively targeted interventions. For prosthesis-related facilitators, potential strategies may include improved prosthetic and rehabilitation care, enhanced clinician education, promotion of peer support relating to prosthetic use and increased access to activity-specific prostheses. Similarly, equipment-related facilitators may be addressed through programs aimed at improving access to adaptive

equipment including equipment loan programs or increased opportunities to trial specialised sporting equipment. Compared with high-resource facilitators such as accessible infrastructure or inclusive communities, these approaches may be more readily implemented across existing healthcare, community and sporting systems. These findings suggest that improvements in participation may be achievable without requiring large-scale system reform, provided appropriate supports and services are available.

Despite the predominance of low-resource facilitators, the findings also highlight that no single intervention is likely to facilitate participation for all individuals with LL. Participants identified a broad range of prosthetic and equipment related requirements, demonstrating the heterogeneity of participation needs within the LL community. To address this, clinicians, service providers and policymakers should adopt flexible, person-centred approaches that recognise diverse needs, preferences and circumstances of individuals living with LL.

The analysis of activity preferences provided important practical context for interpreting facilitator findings. Participants reported interest in a broad range of sporting and recreational activities, which align with many of those identified in previous research including walking, swimming, cycling, fitness training and golf (Bragaru et al., 2011; Hofer et al., 2022; Kars et al., 2009). Importantly, many preferred activities were classified as requiring low individual resources to participate in. This is an encouraging finding, suggesting that numerous activities desired by Australians living with LL may be reasonably accessible from a personal cost and equipment perspective. Therefore, sporting organisations and community programs have an opportunity to promote participation in these more accessible activities and increase engagement in sport and PA. Nonetheless, participants are still consistently reporting the need for specific prostheses and adapted equipment to facilitate participation. This may suggest that participation is influenced more strongly by access to appropriate prostheses and adapted equipment than by the individual resource requirements of the activities themselves.

Clinicians, policymakers and organisations should consider not only the activities individuals want to participate in, but also the supports and services required to facilitate that participation. These findings further reinforce that no single intervention is likely to meet the needs of all individuals, highlighting the importance of flexible, person-centred approaches.

Strengths

To the author's knowledge, this study is one of few of its kind that examines facilitators to sport and PA participation among individuals living with LL and activity preferences according to perceived resource requirements. This resource-based approach provides a novel perspective on facilitators and activities that may be more readily addressed or supported through targeted interventions or service improvements. The study also contributes Australian-specific evidence to an area of research that has been predominantly conducted internationally and captured responses from 111 participants, representing a relatively large sample for qualitative research in this population. Collaboration with L4L throughout survey development and participant recruitment enhanced the relevance of the study to the Australian LL community. Methodological rigour was maintained through adherence to Braun and Clarke's reflexive thematic analysis approach, iterative coding and collaborative discussions throughout data analysis.

Limitations

Several limitations should be considered when interpreting the findings of this study. The use of an ad hoc survey instrument and retrospective analysis may have introduced response or selection bias and thereby limits possible comparisons with existing observational studies. The broad and open-ended nature of the facilitator question resulted in six responses lacking detail, being unclear or unrelated to sport and PA participation, limiting the depth of interpretation. Several important confounders were not collected including prosthesis type,

time since amputation, socioeconomic status, current PA levels, access to healthcare and prosthetic services, and comorbidities. Overlooking these variables limits the ability to contextualise participant responses and holistically understand factors influencing facilitators or activity preferences. The absence of stratified analyses also limited the ability to explore whether facilitators or activity preferences differed according to demographic or clinical characteristics (e.g., gender, age, level of amputation). The survey was also not designed to collect information regarding participants' current prosthetic use or access to specialised prosthetic devices required to participate in preferred activities. Consequently, classifications of individual-level resource requirements assumed that participants had access to the prosthetic devices or components necessary to engage in the activities. While this approach enabled consistent classification of activities, it may have resulted in an underestimation of the individual resources required for participation and biased findings towards lower individual resource classifications. The classification of facilitators and activities according to perceived resource requirements was also based on researcher interpretation, subjective judgement and collaborative discussion. As no established framework currently exists for categorising facilitators or activities according to resource requirements, these classifications should be interpreted as exploratory. This study also overlooked specific financial costs as well as establishing objective thresholds for low and high-resource categories, as this was deemed beyond the scope of this study.

Implications for Practice and Future Research

These findings provide a basis for the development of targeted interventions and healthcare service delivery aimed at improving sport and PA participation among Australians living with LL. By identifying facilitators that may be addressed through relatively lower resources, the findings provide direction for interventions and program development. Future research should determine and explore how these facilitators can be translated into practical interventions and

integrated across existing healthcare, community and sporting systems. Evaluating different models of service delivery and program implementation may assist in identifying sustainable holistic approaches that improve participation outcomes.

The findings also may inform future data collection. Building on the strengths and limitations of the pilot survey, development of a validated survey instrument capable of assessing barriers, facilitators, activity preferences and relevant participant characteristics would improve transferability across studies. Such a design would enable stratified analyses, facilitate comparisons between Australian and international populations and provide stronger evidence to inform policy and service delivery. Investigation of the interaction between barriers and facilitators is also warranted. Many facilitator themes identified in this study appeared to directly correspond with barriers previously identified within the broader project, suggesting that they may represent opposite sides of the same participation experience. Examining these relationships may assist in identifying interventions capable of simultaneously reducing barriers while strengthening facilitators. Further refinement of the proposed resource-based framework is required. Objective resource and cost analyses would strengthen the categorisation and understanding of the relative feasibility of participating in preferred activities and implementing facilitators. This information would provide healthcare organisations, sporting bodies and policymakers with a stronger basis for prioritising changes according to their resource requirements and potential impact. The method developed and the outcomes may also inform the design and facilitate knowledge transfer to other populations with physical disability, particularly those with limited mobility.

Conclusion

This study provides a new insight into the environmental facilitators that support sport and PA participation among Australians living with LL. Prosthesis and equipment related facilitators

were identified as the two environmental themes classified as requiring relatively low resources to address, suggesting that many facilitators may be addressed through targeted patient, clinical and service level interventions rather than requiring broader infrastructure or system-level change. An encouraging finding was that many of the preferred sporting and recreational activities were classified as also requiring relatively low individual resources to participate in. This suggests that many activities desired by the LL community may already be achievable from a personal cost and equipment perspective and could therefore be promoted through community and sporting programs to encourage greater participation. Nonetheless, the facilitator findings demonstrate that participants consistently identified the need for well-fitting, comfortable, activity-specific prostheses and adaptive equipment to enable participation. This suggests that participation may depend less on the resource demands of the activity itself and more on ensuring individuals have the appropriate prosthetic and equipment to participate in the activities they value.

These findings provide practical direction for healthcare organisations, clinicians, sporting bodies and policymakers seeking to improve participation among the LL community. Future efforts should focus on translating these findings into practical interventions that improve prosthetic care, clinician education, peer-support and access to activity-specific prostheses and adaptive equipment. With the Brisbane 2032 Paralympic Games approaching, these findings provide timely evidence to support initiatives that increase opportunities for participation in sport and PA for Australians living with LL.

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Appendices

Appendix A: Survey Administered to Respondents

Introduction

Limbs 4 Life are interested to learn about the things which stop you from taking part in recreational and sporting activities. This survey is anonymous and will only take you 6 minutes to complete.

Your feedback is important to us.

Obstacles to participation to recreational or sporting activities?

What is the main barrier preventing you from participating in recreational or sporting activities? ***Open comment***

If you had a magic wand, what item would you have / create that should help you to participate more to recreational or sporting activities ? ***Open comment***

List the 5 mains to recreational or sporting activities you would like to participate in?

- _____
- _____
- _____
- _____
- _____

About you?

Please tell us which state/territory you live in?

Australian Capital Territory (ACT)

New South Wales

Northern Territory

Queensland

South Australia

Tasmania

Victoria

Western Australia

Please tell us your gender

Male

Female

Transgender

Non-binary

Prefer not to say

Please tell us which age group you fit into?

- 12 or under
- 13 - 18
- 20 - 29
- 30-39
- 40-49
- 50-59
- 60 – 69
- 70 – 79
- 80+

Please tell us your level of amputation

Lower limb

Partial foot

Symes

Below knee

Through knee

Above knee

Hemipelvectomy

Bilateral below

Bilateral above

Upper limb

Partial hand

Hand

Below elbow

Above elbow

Shoulder disarticulation

Bilateral upper limb

Quad amputee

Appendix B: Environmental Facilitators Lexicon

Environmental Facilitators		
Overarching Categories		
LABEL	DESCRIPTION	CRITERIA
Environmental	Factors external to the individual.	Responses referring to environmental, social, structural, technological or systemic factors independent of the person.
Personal	Factors internal to the individual.	Responses referring to facilitators dependent on the person themselves (e.g., physical or psychological factors).
Main Themes (Low-Resources)		
THEME	DESCRIPTION	CRITERIA
Equipment	Facilitators relating to tools or aids (excluding prostheses).	Responses referring to adapted, specialised or modified equipment.
Prosthesis	Facilitators related to artificial limbs.	Responses describing prosthesis fit, comfort, functionality or design.
Subthemes (Low-Resources)		
SUBTHEME	DESCRIPTION	CRITERIA
Adapted Equipment	Availability, access or suitability of modified or specialised equipment.	Responses describing equipment designed, adapted or modified for limb loss.

Fitting & Comfort of Prosthesis	Fit, comfort or attachment of prosthesis to the residual limb.	Responses highlighting socket fit, comfort, sizing, attachment and reduced discomfort during prosthesis use.
Reliability & Function of Prosthesis	Prosthesis suitable and reliable for desired activities.	Responses describing appropriate flexibility, durability, movement stability or overall prosthetic performance.
Purpose Built Prostheses & Accessories	Prostheses or accessories designed for specific activities or purposes	Responses referring to sport or activity-specific prostheses, specific prosthetic components, bionic limbs or prosthetic accessories.
Main Themes (High-Resources)		
THEME	DESCRIPTION	CRITERIA
Activities	Facilitators relating to organised events, programs, or group participation.	Responses describing availability of activity opportunities tailored for people with limb loss.
Support	Facilitators related to social, emotional, or informational assistance.	Responses referencing adequate guidance, resources and peer/family/organisational support.
Access	Facilitators related to physical or environmental accessibility.	Responses highlighting accessible transport, facilities, or structures.
Funding	Facilitators relating to financial resources or systemic funding allocation.	Responses referring to government support, subsidies, or funding mechanisms.
Subthemes (High-Resources)		

SUBTHEME	DESCRIPTION	CRITERIA
Inclusive Programs	Available opportunities or programs adapted to people with limb loss.	Responses referencing adapted sport programs, recreational groups or inclusive activities.
Information	Access to resources, education, or guidance.	Responses referring to awareness of or knowledge of programs, resources or educational support.
Community	Social, peer, or family support.	Responses referring to sufficient encouragement or social networks.
Transport	Availability and ability to travel to/from activity locations.	Responses referring to inclusive or reliable transport options and assistance.
Accessibility	Physical accessibility within facilities or environments.	Responses referring to accessible stairs, ramps, pathways or venue design.

Appendix C: Activity Preferences Lexicon

LABEL	**DEFINITION**	**EXAMPLE ACTIVITIES**
ACTIVITY CATEGORIES		
Walking	Activities involving walking at a self-selected pace for physical activity, transport, or leisure.	Walking, bushwalking, beach walking, dog walking.
Running	Activities involving running at speeds faster than walking.	Running.
Cycling	Activities involving pedalling motion for physical activity or	Cycling, bike riding, mountain bike riding.

	transport using bicycles, or adaptive hand cycles.	
Water Sports	Aquatic-based sports and recreational activities.	Swimming, diving, canoeing, fishing, boogie boarding.
Wheelchair	Sports or recreational activities performed using a wheelchair.	Wheelchair basketball, wheelchair marathon, wheelchair table tennis.
Gym	Activities involving structured exercise, strength training or conditioning that are typically performed within a gym or fitness environment.	Aerobics, powerlifting, Pilates, gym-biking, CrossFit, fitness classes
Team Activities	Team-based sporting activities that do not fall within the walking, running, cycling, water sports, wheelchair or gym categories.	AFL, netball, basketball, football, hockey, rugby league.
Miscellaneous Sport	Activities involving formal rules and organised participation that typically occur within a formal structure or competition that do not fit within the other categories.	Tennis, gymnastics, golf, badminton.
Miscellaneous Recreational	Activities that do not have formal rules or competition and are engaged in for relaxation, health and wellbeing or enjoyment that	Gardening, pottery, rock climbing, abseiling, snowboarding

	do not fit within the other categories.	
ACTIVITY CLASSIFICATIONS		
Activities		
Sport	Activities involving formal rules and organised participation that typically occur within a formal structure or competition.	Soccer, tennis, basketball, netball, cricket.
Recreational	Activities that do not have formal rules or competition and are engaged in for relaxation, health and wellbeing or enjoyment.	Walking, surfing, dancing, gardening.
Social		
Individual	Activities performed independently, and not reliant on teammates or group participation to perform.	Walking, running, cycling, surfing, Para powerlifting.
Team	Activities requiring teammates or group participation to participate.	Rugby league, soccer, netball, basketball.
Environment		
Indoor	Activities primarily conducted within enclosed environments, such as gyms, studios or indoor facilities.	Billiards, gymnastics, table tennis, darts.

Outdoor	Activities primarily conducted in open or natural environments.	Snowboarding, mowing, clay shooting, rugby league.
Adaptation		
Mainstream	Activities that are not modified to accommodate limb loss.	Cricket, gymnastics, golf, netball.
Adapted	Based on the Paralympics Australian para-sport registry, activities that can be modified to accommodate limb loss through adapted equipment, rule modification, or specialised environments.	Archery, cycling, lawn bowls, kayaking. wheelchair sport.
Resources		
Individual-Low	Activities requiring minimal personal financial investment, cost, equipment or other individual resources to participate (assuming access to the prosthetic device required for participation).	Walking, running, basketball, yoga, darts.
Individual-High	Activities requiring substantial personal financial investment, cost, specialised equipment or other individual resources to participate.	Cycling, skiing, golf, horse riding, scuba-diving.

Environmental-Low	Activities requiring minimal infrastructure, facilities or specialised environments to participate.	Walking, running, beach swimming, boogieboarding, cycling.
Environmental-High	Activities requiring specialised facilities, infrastructure or environments (i.e. stadiums, pools) to participate.	Netball, CrossFit, golf, gymnastics, swimming.

Appendix D: Personal Facilitator Themes and Subthemes

Main Theme	**Subtheme**	**N (%)**
Body	Mobility	1 (1%)
	Age	3 (3%)
	Comorbidities	1 (1%)
	Balance	3 (3%)
	Physical Fitness	1 (1%)
Mind	Perception of Disability	12 (11%)
	Confidence	3 (3%)
	Interest and Motivation	2 (2%)

Appendix E: Statement of Contribution Form – Tania Brancato Best

School of Exercise and Nutrition Sciences

STATEMENT OF CONTRIBUTION TO HONOURS THESIS AND DATA RETURN

This thesis includes a co-authored paper. Please note assistance from supervisor is expected.

My contribution to the thesis and paper involved (please tick all that are relevant):

Writing of ethics application
- ☐ with NO assistance from supervisor
- ☐ with assistance from project partner
- ☐ with assistance from supervisor
- ☒ supervisor only
- ☐ not applicable

Development of research instruments/measures/tools
- ☐ with NO assistance from supervisor
- ☐ with assistance from project partner
- ☐ with assistance from supervisor
- ☒ supervisor only
- ☐ not applicable

Collection of data
- ☐ with NO assistance from supervisor
- ☐ with assistance from project partner
- ☐ with assistance from supervisor
- ☒ supervisor only
- ☐ not applicable

Preliminary data analysis and categorisation of data into a useable format*
- ☐ with NO assistance from supervisor
- ☒ with assistance from project partner
- ☒ with assistance from supervisor
- ☐ supervisor only
- ☐ not applicable

Interpretation of results
- ☒ with NO assistance from supervisor
- ☐ with assistance from project partner
- ☐ with assistance from supervisor
- ☐ supervisor only
- ☐ not applicable

Structuring of paper
- ☒ with NO assistance from supervisor
- ☐ with assistance from supervisor
- ☐ supervisor only
- ☐ not applicable

September 2026

Editing of paper

☒ with NO assistance from supervisor

☐ with assistance from supervisor: my supervisor provided comments on my paper

RETURN OF DATA

I have returned all study data files to my supervisor at QUT

(Signed) _____ (Date) 12/10/2026_____
Name: Kelsey Woolley

(Countersigned) ___ _(Date)___28/10/2026
Supervisor: Tania Brancato Best

*qualitative work would require the inclusion of the supervisor in the data analysis. For Honours some involvement of the supervisor in the analysis would be expected.

Provide any additional comments if needed:

DATA RETURN

Part of the research process is to store data securely and have it accessible for checking and/or future use

☒ return of data

I have returned all study data files to my supervisor at QUT

(Signed) _____ (Date)__12/10/2026____
Name: Kelsey Woolley

☒ receipt of returned data

I have received all study data files and stored them in the QUT data repository/data storage site listed in the protocol

(Countersigned) __ _____ (Date)__28/102/2026_
Supervisor: Tania Brancato Best

September 2026

Appendix F: Statement of Contribution Form – Laurent Frossard

School of Exercise and Nutrition Sciences

STATEMENT OF CONTRIBUTION TO HONOURS THESIS AND DATA RETURN

This thesis includes a co-authored paper. Please note assistance from supervisor is expected.

My contribution to the thesis and paper involved (please tick all that are relevant):

Writing of ethics application
- ☐ with NO assistance from supervisor
- ☐ with assistance from project partner
- ☐ with assistance from supervisor
- ☒ supervisor only
- ☐ not applicable

Development of research instruments/measures/tools
- ☐ with NO assistance from supervisor
- ☐ with assistance from project partner
- ☐ with assistance from supervisor
- ☒ supervisor only
- ☐ not applicable

Collection of data
- ☐ with NO assistance from supervisor
- ☐ with assistance from project partner
- ☐ with assistance from supervisor
- ☒ supervisor only
- ☐ not applicable

Preliminary data analysis and categorisation of data into a useable format*
- ☐ with NO assistance from supervisor
- ☒ with assistance from project partner
- ☒ with assistance from supervisor
- ☐ supervisor only
- ☐ not applicable

Interpretation of results
- ☒ with NO assistance from supervisor
- ☐ with assistance from project partner
- ☐ with assistance from supervisor
- ☐ supervisor only
- ☐ not applicable

Structuring of paper
- ☐ with NO assistance from supervisor
- ☒ with assistance from supervisor
- ☐ supervisor only
- ☐ not applicable

September 2026

Editing of paper

☐ with NO assistance from supervisor

☒ with assistance from supervisor: my supervisor provided comments on my paper – once

RETURN OF DATA

I have returned all study data files to my supervisor at QUT

(Signed) _____ (Date) 12/10/2026

Name: Kelsey Woolley

(Countersigned) _____ (Date) 14/10/2026

Supervisor: Laurent Frossard

*qualitative work would require the inclusion of the supervisor in the data analysis. For Honours some involvement of the supervisor in the analysis would be expected.

Provide any additional comments if needed:

DATA RETURN

Part of the research process is to store data securely and have it accessible for checking and/or future use

☒ return of data

I have returned all study data files to my supervisor at QUT

(Signed) _____ (Date) 12/10/2026

Name: Kelsey Woolley

☒ receipt of returned data

I have received all study data files and stored them in the QUT data repository/data storage site listed in the protocol

(Countersigned) _____ (Date) 14/10/2026

Supervisor: Laurent Frossard