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# Association between prosthesis use to the physical functioning and quality of life among adult unilateral lower limb amputees: An analytical cross-sectional study\*

Gian Searle S. Alkuino, RMT<sup>1</sup>; Marvin N. Catoy<sup>1</sup>; Shieka Delanne G. Alo, RPh<sup>1</sup>; Chloe Ysabel B. Allanigue, OTRP<sup>1</sup>; Sheen Queenae C. Catamin, RMT<sup>1</sup>; Sam Francesca P. Cirilo, RN<sup>1</sup>; Walled T. Ali<sup>1</sup>; Francine Gaile D. Co, RND<sup>1</sup>; Josephine R. Bundoc, MD, FPARM<sup>1,2</sup>; Ramon Jason M. Javier, MD, MSTM, FPAFP<sup>1,3</sup>

## Abstract

**Introduction** A prosthesis is an artificial assistive device designed to replace a missing body part (e.g., limb), secondary to a disease, injury or congenital deformities. Prostheses are often used to restore functional capacity while improving the quality of life (QoL).

**Methods** An analytical cross-sectional study was conducted among adults aged 19 to 64 years who were permanent residents in Luzon who had undergone unilateral lower leg amputation. This epidemiologic study employed the Modified Barthel Index for activities of daily living (ADLs), the Frenchay Activities Index for instrumental activities of daily living (IADLs), and the WHOQOL-BREF for QoL. Descriptive and analytical statistics of the responses of the Lower Limb Amputees (LLA) were done. Prevalence odds ratio (POR) was calculated, and statistical significance was determined.

**Results** Among 165 LLA respondents, only 47.88% used prostheses. Unilateral LLA who exhibited greater independence in ADLs (POR=19.22), more actively performed IADLs (POR=5.51), and had good QoL (POR=3.83) were more likely to have been using prosthesis. All these findings were statistically significant.

**Conclusion** This study revealed a statistically significant association between prosthesis use to the physical functioning and QoL among adult unilateral LLAs. It showed that prosthetic use was likely linked with improved performance in ADLs and IADLs, and better QoL compared to those without.

**Key words:** prosthesis, functional capacity, quality of life

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Correspondence: Gian Searle S. Alkuino, College of Medicine, University of the East Ramon Magsaysay Memorial Medical Center, Inc., Quezon City, Philippines;  
Email: alkuinog1558@uerm.edu.ph

<sup>1</sup>College of Medicine, University of the East Ramon Magsaysay Memorial Medical Center, Inc., Quezon City, Philippines.

<sup>2</sup>Section of Physical Medicine and Rehabilitation, Department of Medicine, College of Medicine, University of the East Ramon Magsaysay Memorial Medical Center, Inc., Quezon City, Philippines.

<sup>3</sup>Department of Preventive and Community Medicine, College of Medicine, University of the East Ramon Magsaysay Memorial Medical Center, Inc., Quezon City, Philippines.

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Amputation results in the removal of a limb, which can be secondary to trauma, chronic disease, or congenital causes.<sup>1</sup> Due to its irreversible nature, amputation renders substantial and lifelong changes in an individual's body structure and function, affecting mobility to a great extent.<sup>2</sup> Restrictions in mobility mainly cause limitations in physical function, which refers to the ability to perform everyday self-care tasks (i.e., activities of daily living / ADLs), as well as daily activities involving interaction with the environment (i.e., instrumental activities of daily living / IADLs).<sup>3</sup>

The effect of physical function creates an adverse and immense impact physically, psychologically, socially, and environmentally – essentially affecting the overall quality of life (QoL). The World Health Organization (WHO) defines QoL as “an individual’s perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns”.<sup>4</sup> Since QoL is linked to overall well-being and satisfaction, people with amputation cope by modifying and adapting their well-established habits and motion patterns through rehabilitation or use of a prosthesis – an artificial device intended to replace a missing part of an extremity.<sup>5</sup>

In the Philippines, over 600,000 amputees were reported in 2018.<sup>6</sup> Relative to other disabling conditions, the proportion of disability due to amputations in the country was less than 1%, based on the 2016 National Disability Prevalence Survey of the Philippine Statistics Authority (PSA).<sup>7</sup> Despite its low prevalence, amputation is a considerable social and economic burden to society and individuals. With limb loss causing multifaceted challenges, artificial limbs intend to provide an individual with the opportunity to perform functional tasks and, in turn, improve QoL. Despite the huge demand and apparent benefits of prosthesis, there seems to be paucity of medical literature in the Philippines that dwell on physical functioning and overall QoL of prosthetic users.<sup>8,9</sup> Little is known to adequately establish whether the use of prostheses among those with lower limb amputation provides significant improvement in their physical function and QoL.

Therefore, the primary objective of this study was to determine association between the use of prosthesis to the physical functioning and QoL among adult unilateral lower limb amputees (LLAs). This epidemiologic investigation could establish, if indeed, prosthesis use could genuinely enhance physical function and more importantly, positively impact the overall QoL. Through this, the study might help provide insight into how LLAs viewed and valued prosthesis use for physical functioning, which could serve as a catalyst for better rehabilitation outcomes for LLAs. In addition, this could likewise potentially improve understanding of the field of rehabilitation medicine, orthotics, and prosthetics, which might potentially further the development of government or non-government services for LLAs.

## Methods

This analytical cross-sectional study compared the level of physical functioning and QoL among LLAs with and without prostheses. This study underwent approval by the Ethics Review Committee of the UERMMMCI Research Institute for Health Sciences.

Respondent recruitment via purposive sampling and data collection was done from July 2023 to October 2023 through face-to-face interviews, phone calls, and online surveys throughout Luzon with the help of government units and non-government organizations. Study respondents met the inclusion criteria, set as follows: 1) Filipino; 2) 19 to 64 years old; 3) residing in Luzon; and 4) who underwent unilateral lower limb amputation. Excluded from this study were individuals who had been using prosthesis for less than six months; those with established neurologic and/or orthopedic impairments (i.e., stroke, cerebral palsy, poliomyelitis); those with insufficient cognitive skills, as well as those with previously diagnosed psychiatric disorders; and those who had congenital limb loss. Out of 197 study respondents, 32 were eventually not included in the study, due to failure of meeting all eligibility criteria or secondary to incomplete responses. Hence, only 165 consenting study respondents were included in the study.

Data were collected using a structured survey questionnaire consisting of a sociodemographic questionnaire and compiled previously validated tools, in particular: 1) the Modified Barthel Index (MBI); 2) the Frenchay Activities Index (FAI); and 3) the WHOQOL-BREF Questionnaire. Since a translated version of one questionnaire was already available, the remaining two questionnaires were translated into the vernacular and pilot tested for internal consistency (i.e., Cronbach’s  $\alpha = 0.936$ ).

The MBI, an 11-item self-care assessment test measured ADL, where a sum score of  $\geq 60$  indicated independence and  $< 60$  implied dependence. Due to its superior test-retest reliability and lower random measurement error in comparison to the original Barthel Index (BI), the MBI was recommended for clinical and research purposes.<sup>10</sup>

The FAI, a 15-item self-care assessment test measured IADL, where a sum score of  $\geq 16$  was considered active and  $< 16$  was inactive, exhibited good retest reliability when discerning group-level distinctions in research involving amputee populations.<sup>11</sup> Consequently, it was recommended

to ensure comparability of results across different populations and studies. Test-retest reliability of the tool among LLAs measured 0.79 with a Cronbach's  $\alpha$  of 0.87.<sup>11,12</sup>

The WHOQOL-BREF was a 26-item assessment test that included each of the 24 facets in WHOQOL-100 as a one-item question with the addition of 2 items from the overall QoL and general health facet.<sup>13</sup> Items were rated on a 5-point scale system from 1 (i.e., not at all) to 5 (i.e., completely). A score of  $\geq 80$  indicated a good QoL, while  $< 80$  was considered poor QoL. The test-retest for all domains of WHOQOL-BREF had an internal reliability measured above 0.70 and a Cronbach's  $\alpha$  of 0.896.<sup>14</sup>

Both the MBI and FAI were scored as the sum of all responses in each questionnaire. The total scores determined the study respondents' capacity for ADLs and IADLs based on the cut-off scores set. For WHOQOL-BREF, responses were recorded per domain of QoL, namely the physical domain, psychological domain, social relationships domain, and environment domain. An overall QoL score, which was the total of all 26 items, was also reported and was used to classify whether an individual had good or poor QoL, based on the set cut-off score.

All of the statistical analyses were done using IBM Statistical Package for Social Sciences (SPSS) Version 29.0.1.0 (171).

## Results

Of the 165 study respondents, 79 (47.88%) were included in the group with prostheses, and 86 (52.12%) were grouped under LLAs without prostheses. The age range of the study respondents was from 21 to 64 years, with the prosthesis group having a computed mean age of ~43 years old, while the group without prosthesis had an average age of ~49 years old. Table 1 shows the sociodemographic profile of the study respondents and other pertinent information on the individual and environmental factors that might have a consequent effect on the overall QoL.<sup>15</sup>

The demographic profile of unilateral LLAs predominantly consisted of males, accounting for approximately 69% of the study respondents across both groups. Among those with prostheses, a significant portion (51.9%) finished tertiary education, whereas only 33.7% of those without prostheses attained the same educational attainment. In terms

of employment status, 46 (58.23%) of those with prostheses were currently employed or could do work, while only 23 (26.74%) of those without prostheses were gainfully employed.

The leading causes of amputation among the study respondents were due to 1) trauma or accidents, 2) complications of diabetes mellitus, and 3) others (i.e., amputation secondary to osteosarcoma, giant cell tumor, osteomyelitis, infection, etc.), comprising 42.42%, 38.79%, and 18.79%, respectively. Between the two groups, however, the predominant causes of amputation were different, with trauma or accidents leading in the group with prosthesis, while complications of diabetes mellitus were the major reason for amputation in the group without prosthesis. Below-knee amputation (BKA) comprised the majority of the responses for each group, with 62.03% with prosthesis and 53.49%, without prosthesis.

Descriptive statistics of the MBI, FAI, and WHOQOL-BREF had been summarized in Table 2, showing the mean and standard deviation of test scores. Both MBI and FAI scores were recorded as the sum of every item in each questionnaire. WHOQOL-BREF raw scores were reported as the sum of specific questions about each domain, and an overall QoL score from the sum of all domains and two general questions regarding perceived QoL. Summarized in Table 3 were the mean and standard deviation of the transformed WHOQOL-BREF scores of each domain.

Unilateral LLAs who performed ADLs with greater independence were 19.22 times more likely to have been using prostheses ( $p$ -value  $< 0.001$ ) (Table 4).

Table 5 shows unilateral LLAs who were more active in performing IADLs were 5.51 times more likely to have been using prostheses, and this association was statistically significant ( $p$ -value  $< 0.001$ ).

Table 6 shows that unilateral LLAs with good QoL were 3.83 times more likely to have prostheses, and this association was statistically significant ( $p$ -value  $< 0.001$ ). These results showed the positive association between the use of prosthesis and physical function (i.e., level of independence on ADLs; level of activity in performing IADLs), as well as QoL, and all were statistically significant.

## Discussion

This epidemiologic investigation determined the proportion of LLAs with prostheses who had good

**Table 1.** Sociodemographic profile.

	Total (N = 165)	With Prosthesis (N = 79)	Without Prosthesis (N = 86)
<b>Sex</b>	N (%)	N (%)	N (%)
Male	114 (69.10)	55 (69.62)	59 (68.60%)
Female	51 (30.90)	24 (30.38)	27 (31.40%)
<b>Educational Attainment</b>			
Did Not Finish School	10 (6.10)	7 (8.90)	3 (3.50%)
Primary Education	14 (8.50)	3 (3.80)	11 (12.80%)
Secondary Education	71 (43.00)	28 (35.40)	43 (50.00%)
Tertiary Education	70 (42.40)	41 (51.90)	29 (33.70%)
<b>Marital Status</b>			
Single	42 (25.45)	26 (32.91)	16 (18.60)
Married	112 (67.88)	46 (58.23)	66 (76.74)
Separated	6 (3.64)	5 (6.33)	1 (1.16)
Widowed	5 (3.03)	2 (2.53)	3 (3.49)
<b>Occupational Status</b>			
Employed	69 (41.82)	46 (58.23)	23 (26.74)
Non-employed	96 (58.18)	33 (41.77)	63 (73.26)
<b>Level of Amputation</b>			
Above the Knee (AKA)	70 (42.42)	30 (37.97)	40 (46.51)
Below the Knee (BKA)	95 (57.58)	49 (62.03)	46 (53.49)
<b>Cause of Amputation</b>			
Trauma / Accidents	70 (42.42)	37 (46.84)	33 (38.37)
Diabetes Complication	64 (38.79)	23 (29.11)	41 (47.67)
Others (infection, cancer)	31 (18.79)	19 (24.05)	12 (13.95)
<b>Presence of Comorbidities</b>			
No Comorbidities	87 (52.73)	51 (64.56)	36 (41.86)
With Comorbidities	78 (47.27)	28 (35.44)	50 (58.14)

**Table 2.** Descriptive statistics for MBI, FAI & WHOQOL-BREF.

	Total (N = 165)		With Prosthesis (N = 79)		Without Prosthesis (N = 86)	
	Mean	SD	Mean	SD	Mean	SD
<b>Modified Barthel Index</b>	83.62	18.18	91.77	10.51	76.14	20.45
<b>Frenchay Activities Index</b>	23.50	10.29	27.95	8.90	19.42	9.82
<b>WHOQOL-BREF</b>						
Physical Domain	23.35	4.96	25.65	4.11	21.23	4.75
Psychological Domain	21.10	4.12	22.57	3.77	19.76	3.98
Social Relationships Domain	10.72	2.43	11.29	2.37	10.19	2.38
Environment Domain	26.19	5.03	27.71	4.89	24.79	4.77
Overall QoL	87.47	15.73	93.86	14.44	81.59	14.59

**Table 3.** Transformed WHOQOL-BREF scores (0-100).

WHOQOL-BREF Transformed Scores (0-100)	With Prosthesis (N = 79)		Without Prosthesis (N = 86)	
	Mean	SD	Mean	SD
Physical Domain	66.43	14.95	50.90	16.98
Psychological Domain	68.86	15.88	57.44	16.70
Social Relationships Domain	69.24	19.68	59.88	20.41
Environment Domain	63.28	15.53	54.06	14.79

**Table 4. 2x2:** Prosthesis use and ability to perform ADLs.

Total (N = 165)	Independent ( $\geq 60$ )	Dependent ( $< 60$ )
With Prosthesis (N = 79)	78	1
Without Prosthesis (N = 86)	69	17

POR: 19.22; p-value < 0.001

**Table 5. 2x2:** Prosthesis use and ability to perform IADLs.

Total (N = 165)	Active ( $\geq 16$ )	Inactive ( $< 16$ )
With Prosthesis (N = 79)	72	7
Without Prosthesis (N = 86)	56	30

POR: 5.51; p-value < 0.001

**Table 6. 2x2:** Prosthesis use and perceived quality of life scores.

Total (N = 165)	Good QoL ( $\geq 80$ )	Poor QoL ( $< 80$ )
With Prosthesis (N = 79)	66	13
Without Prosthesis (N = 86)	49	37

POR: 3.83; p-value < 0.001

physical functioning and a good QoL. Furthermore, this study hypothesized that the use of prostheses would have a positive association with enhanced physical function and QoL.

The findings of this research were consistent with a previous study in Turkey, which demonstrated that individuals below 65 years old with lower limb amputations exhibited significantly improved physical balance, greater satisfaction with their prostheses, and enhanced performance in ADLs.<sup>16</sup> As shown by the results, unilateral LLAs who used prosthetics were more inclined to maintain independence in carrying out ADLs, in contrast to those without prosthetics.

This was corroborated by a Malaysian study, which showed a significant association between the mobility aids used and the level of independence ( $p < 0.001$ ). Specifically, individuals with prostheses exhibited greater independence in ADL compared to those using standard wheelchairs and standard walkers.<sup>17</sup> The research findings were also consistent with prior epidemiologic investigations where study respondents emphasized the personally significant aspects of using prosthetics. These aspects encompassed values such as a sense of purpose, enthusiasm, and the capability to perform ADLs that prosthetics facilitate. This highlighted that concerns related to prosthetic use

extended beyond their functional aspects, aligning with our study's results.<sup>18</sup> Hence, prostheses had been shown to improve the QoL of LLAs by providing normal body image and increasing physical capabilities.<sup>19</sup> Furthermore, a study also stated that the QoL and general satisfaction of people with LLA were positively correlated with the fit and socket comfort of the prosthesis.<sup>20</sup>

As shown in the current study, unilateral LLAs who used prostheses were more active in terms of the overall performance of IADLs in contrast to those without prostheses, with only 9% of prosthesis users reporting inactivity. These findings were consistent with a previous study where 67% of war veteran amputees had complete independence in taking their medicine, and 70% were able to perform financial activities.<sup>15</sup> Another study reported a high percentage of independence on telephone use, food preparation, housekeeping, laundry, and the ability to handle finances with limitations on IADLs, like shopping, and traveling.<sup>21</sup> While the most dependent domains of the LLAs were housekeeping, food preparation, and laundry, their results were still consistent with the current results of this cross-sectional study, as most of them were still independent of the other domains of IADL, with the highest percentage on telephone use followed by medication intake.<sup>15</sup> These collective findings suggest a positive relationship between the utilization of prostheses among LLAs and their overall performance in IADLs.<sup>21</sup>

As shown by the study results, there was a statistically significant association between the unilateral LLAs with prosthesis and a good QoL. These results were consistent with previous studies, which demonstrated that the overall QoL among LLAs with prostheses was either satisfactory or good.<sup>9,22-25</sup> In a systematic review of literature covering multiple QoL measures, walking with a prosthesis was considered the most notable factor positively influencing QoL amongst LLAs.<sup>26</sup> All four domains reflected a positive impact on QoL with the social relationships domain obtaining the highest transformed score, followed by psychological, then physical, and the environment domain getting the lowest transformed score. While all the scores indicated a level of satisfaction indicative of a good overall QoL, the low ranking for the physical domain was reflective of another study where it obtained the lowest score. Their study attributed this to the restriction that amputation had imposed on the respondent's physical mobility, which

was considered to be a significant factor to QoL in LLAs.<sup>22,27</sup> Thus, rehabilitation efforts with a focus on improving mobility were emphasized to likely enhance the overall QoL of LLAs.<sup>27</sup> On the other hand, the highest ranking for the social relationships domain aligned with another epidemiologic investigation, which expressed that study respondents valued social standing and relationships with family and friends more than physical ability. This emphasized that the ability to achieve social integration as part of the post-amputation rehabilitation process was deemed more desirable than physical activity or even personal psychological well-being.<sup>28</sup>

The World Report on Disability of the World Health Organization (WHO) highlighted the significant role of the environment in facilitating or restricting participation for people with disabilities, including LLAs. The environment domain getting the lowest transformed score could have stemmed from the observation that there was widespread evidence of environmental barriers that prevented people with disabilities and LLAs from exercising their full autonomy even if they had acquired prostheses.<sup>29</sup> In the National Disability Prevalence Survey of the PSA, it was reported that such barriers included limited community and citizenship participation; constrained accessibility to education or school, work, establishments, health facilities, places of leisure and worship, and transportation; and inadequate access to information and health care services.<sup>7</sup> These disabling barriers contributed to the disadvantages experienced by people with disabilities.

The presence of poor ADL was associated with a decreased QoL, indicating poor physical health. Given the significance of respondents' functional dependence level and their capacity to perform ADL in relation to QoL, these factors were poised to exert a direct influence on overall quality of life.<sup>30</sup> Nonetheless, the mean scores in terms of the physical, psychological, social relationships, and environment domains among the unilateral LLAs with prostheses were generally greater than those without prostheses, highlighting the better scores in perceived QoL by those with prostheses. Other epidemiologic investigations reported the same findings, where unilateral LLAs with prostheses scored better on all four domains.<sup>9,22</sup> A previous study suggested that even though Thai LLAs would face various physical hindrances at the workplace, work was still perceived positively as a source of life's purpose, enhanced

self-esteem, financial security, and reduced social isolation.<sup>9</sup>

The investigators focused on how the utilization of prosthetics with the sociodemographic profile, ability to do ADLs and IADLs, and capacity to have QoL would impact the level of physical functioning and QoL. This focus, however, was centered around adult unilateral LLAs only. Other studies indicated that bilateral lower limb amputees had displayed an impressive ADL score exceeding 90%; or that the relationship between the combined scores for ADL and IADL, while only showing a moderate correlation, was still statistically significant.<sup>31</sup> In addition, other studies showed that better QoL was associated with LLAs who were amputated in their younger years, compared to those who were amputated when they were older, since it gave them time to process and adapt to their new life setup. Educational attainment also played a pivotal role in the QoL of LLAs as it provided them with a greater opportunity to be employed, leading to potential stable financial gains, a sense of purpose, and life satisfaction.<sup>9</sup> Although the data on employment were observed to be significantly different among the two groups, this study was not able to determine the effect of prosthesis on employability or capacity to return to work. A finding from a local study demonstrated that the length of prosthesis use was a critical factor associated with physical health QoL scores, as a longer duration of prosthesis use equated to better adjustment to the physical limitations, capabilities, and health rating.<sup>32</sup> The investigators were also not able to quantify the duration of prosthesis use among LLAs.

To enhance the physical functioning and QoL of adult unilateral LLAs, it is highly recommended that healthcare professionals consider prosthesis use as a potential intervention.<sup>33</sup> Healthcare systems should strive to make prosthetic devices more accessible, especially to those with financial limitations. The need for patient education and counseling regarding the benefits of using a prosthesis ought to be highlighted.<sup>34</sup> Healthcare professionals are encouraged to engage patients in detailed discussions on how prosthetics might improve QoL and capacity for everyday activities.

This epidemiologic study was limited to unilateral LLAs residing in Luzon, which curtailed generalizability to the greater number of Filipino LLAs. In addition, the survey questionnaires employed in this research might be susceptible to

social desirability and recall biases. Other unmeasured factors might potentially have an impact on the outcomes. Aside from these, there was a lack of related literature, which tackled the ADL, IADL, and QoL of LLAs with and without prosthesis, highlighting the novelty of this study. The variety of tools used to gather data underscored the lack of universally accepted standards, which presented a challenge in comparing the results of this study with the others.

## Conclusion

There was a statistically significant association between the use of prosthesis to physical functioning and QoL among adult unilateral LLAs. In addition, the data suggested that among adults with unilateral LLAs who were able to perform ADLs more independently and IADLs more actively, there were the prosthesis users. All of these positive associations were also statistically significant (i.e., p-value < 0.001).

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