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전문 돌봄제공자의 목욕 및 배설 돌봄로봇 제품 선호도 분석: 이산선택실험 연구

A Discrete Choice Experiment on Professional Caregivers' Preferences for Bathing and Excretion Care Robots

Yong Soon Shin[1] and Mi Young Kim[1],*

[1]*College of Nursing, Hanyang University, Seoul, Republic of Korea*

Abstract

This study aimed to identify the preferences of professional caregivers with respect to the functional attributes of bathing and excretion care robots by means of a discrete choice experiment (DCE). Twenty-three professional caregivers each responded to seven choice sets per robot type. A mixed logit model revealed that, for the bathing care robot, the automatic patient-transfer function elicited the strongest positive preference, whereas higher monthly rental cost significantly reduced the probability of selection. For the excretion care robot, participants displayed strong positive preferences for automatic waste disposal, combined urine-and-faeces detection, and post-defecation washing and drying — indicating that hygiene automation is highly valued. Relative-importance analysis identified price as the single most influential attribute for bathing care robots (58.5%), whereas automatic waste management was most critical for excretion care robots (30.4%). These findings underscore the caregivers' emphasis on functions that reduce physical and hygienic burden and their sensitivity to service cost, and they provide practical implications for user-centred robot design, pricing strategy, and reimbursement policy aimed at facilitating the effective adoption of care robots in long-term care settings.

Keywords: *care robots, discrete choice experiment, caregiver preferences, bathing care, excretion care*

I. Introduction

1. Background

The global ageing of the population continues to expand the number of persons who need long-term care, and this transition is progressing particularly quickly in the Republic of Korea. In 2025, persons aged 65 or over account for 20.3% of the total population — 10.514 million people — and this share is projected to exceed 30% by 2036 and 40% by 2050 [1]. The old-age dependency ratio (the number of persons aged 65 or over per 100 working-age persons) will rise from 29.3 in 2025 to 47.7 in 2035 and 77.3 in 2050 [1]. As a result, care demand is rising sharply and the burden on professional caregivers — physical, emotional and time — has intensified, contributing to high rates of occupational injury, burnout and workforce turnover.

Care robots have been proposed as one response to this burden [2, 3]. However, evidence on which product attributes actually drive caregiver adoption remains fragmentary [4]. Existing work has concentrated on general acceptance factors — attitudes, intention to use, perceived usefulness, ease of use, financial risk, trust, and quality of life [5, 6] — and has rarely quantified the relative importance of specific device attributes. The discrete choice experiment (DCE) methodology, in contrast, is designed precisely to elicit such trade-offs and is widely used to value health-care services and technologies [7]. Prior DCE applications have covered service robots more generally [8], dementia-related community-care preferences [9], and human-versus-robot care decisions under uncertainty [10]. Bathing and excretion care are the two care domains in which professional caregivers

consistently report the highest physical and emotional burden [11, 12], which makes them the natural focus for a DCE.

2. Objectives

The objective of the present study was to apply a DCE to a cohort of professional caregivers in order to quantify their preferences for the principal attributes of bathing and excretion care robots, and to derive the relative importance of each attribute.

II. Methods

1. Study design

The study followed the standard four-stage DCE workflow described by Chen and colleagues [13]: (i) identification of relevant attributes and their levels; (ii) construction of an experimental design and questionnaire; (iii) fielding of the experiment and data collection; and (iv) analysis of the resulting choice data.

2. Attributes and levels

A literature review and expert consultation initially identified 16 candidate attributes for the bathing care robot and 11 for the excretion care robot. Two care experts screened these for redundancy, importance and urgency, reducing each list to six attributes. Three additional experts with hands-on experience of care robots then narrowed each list to the final four attributes. This is consistent with methodological guidance that a DCE should include no more than six attributes, with two to four levels per attribute [14].

Table 1. Attributes, definitions and levels for the bathing care robot.

Attribute	Level 1	Level 2	Level 3
Bathing method	Shower and mist only (automatic dispensing of water and liquid soap)	Shower, mist and tub bath (automatic dispensing of water and liquid soap)	—
Automatic post-bath cleaning	No	Yes	—
Automatic patient transfer	No	Yes	—
Monthly rental price (KRW)	100,000	500,000	1,000,000

Table 2. Attributes, definitions and levels for the excretion care robot.

Attribute	Level 1	Level 2	Level 3
Excretion processing	Urine detection and aspiration only	Detection and aspiration of both urine and faeces	—
Automatic waste-reservoir disposal	No	Yes	—
Post-defecation washing and drying	No	Yes	—
Monthly rental price (KRW)	50,000	150,000	300,000

3. Experimental design and choice sets

For each robot type, an orthogonal main-effects design implemented in IBM SPSS Statistics 26.0 generated eight representative scenarios from the full factorial. One scenario, containing intermediate attribute levels, was

designated as the reference option (Option A) and paired with each of the remaining seven scenarios (Option B), producing seven binary choice sets per participant per robot type.

4. Data collection

Data collection took place between 12 May and 30 May 2026. A total of 23 professional caregivers completed the DCE questionnaire.

5. Statistical analysis

Analyses were performed with R version 4.3.1 and RStudio. A standard multinomial logit (MNL) model was first fitted, followed by a mixed logit (MXL) model using simulated maximum likelihood (SML). The MXL model was retained as the primary specification because it accommodates unobserved preference heterogeneity across respondents.

III. Results

1. General characteristics

Table 5. General characteristics of participants (N = 23).

Variable	Category	n (%) / M ± SD
Sex	Female	23 (100.0)
Age (years)	20s	3 (13.1)
	30s	12 (52.2)
	40s	7 (30.4)
	50s	1 (4.3)
	Mean	37.6 ± 7.1
Care experience (years)	1–3	3 (13.0)
	4–6	4 (17.4)
	7–9	6 (26.1)
	≥10	10 (43.5)
	Mean	9.3 ± 5.0

2. Preferences and relative importance

2.1 Bathing care robot

Moving from mist bathing to full tub bathing did not significantly increase the probability of selection (β = 0.65, 95% CI [−0.28, 1.57], p = .218). Automatic post-bath cleaning was borderline (β = 0.53, 95% CI [−0.34, 1.41], p = .052). In contrast, the presence of automatic patient transfer produced a significant increase in preference (β = 1.25, 95% CI [0.23, 2.27], p = .003). The monthly rental price entered the model with a negative coefficient (β = −0.03, 95% CI [−0.05, −0.02], p < .001), i.e., higher rental reduced selection probability. In terms of relative importance, monthly rental price accounted for 58.5%, followed by automatic transfer 21.4%, bathing method 10.9%, and automatic cleaning 9.2%.

Table 6. Mixed logit estimates and relative importance — bathing care robot (N = 23).

Attribute (level change)	β	95% CI	p	Relative importance (%)

Bathing method (mist → tub)	0.65	[−0.28, 1.57]	.218	10.9
Automatic cleaning (no → yes)	0.53	[−0.34, 1.41]	.052	9.2
Automatic patient transfer (no → yes)	1.25	[0.23, 2.27]	.003	21.4
Monthly rental price (per KRW 10,000)	−0.03	[−0.05, −0.02]	<.001	58.5

2.2 Excretion care robot

Moving from urine-only detection to combined urine-and-faeces detection increased selection probability significantly (β = 1.23, 95% CI [0.57, 1.89], p = .003). Automatic disposal of the waste reservoir was also significant (β = 1.42, 95% CI [0.54, 2.30], p = .010), as were post-defecation washing and drying (β = 1.04, 95% CI [0.19, 1.90], p = .035). The monthly rental price again entered with a negative coefficient (β = −0.04, 95% CI [−0.08, −0.00], p = .047). In terms of relative importance, automatic waste disposal ranked first (30.4%), followed by urine-and-faeces detection (26.4%), post-defecation washing and drying (22.3%), and monthly rental price (21.0%).

Table 7. Mixed logit estimates and relative importance — excretion care robot (N = 23).

Attribute (level change)	β	95% CI	p	Relative importance (%)
Excretion detection (urine only → urine + faeces)	1.23	[0.57, 1.89]	.003	26.4
Automatic reservoir disposal (no → yes)	1.42	[0.54, 2.30]	.010	30.4
Post-defecation washing and drying (no → yes)	1.04	[0.19, 1.90]	.035	22.3
Monthly rental price (per KRW 10,000)	−0.04	[−0.08, −0.00]	.047	21.0

Fig. 1. Attribute preferences and relative importance for bathing and excretion care robots (mixed logit model, n = 23 professional caregivers)

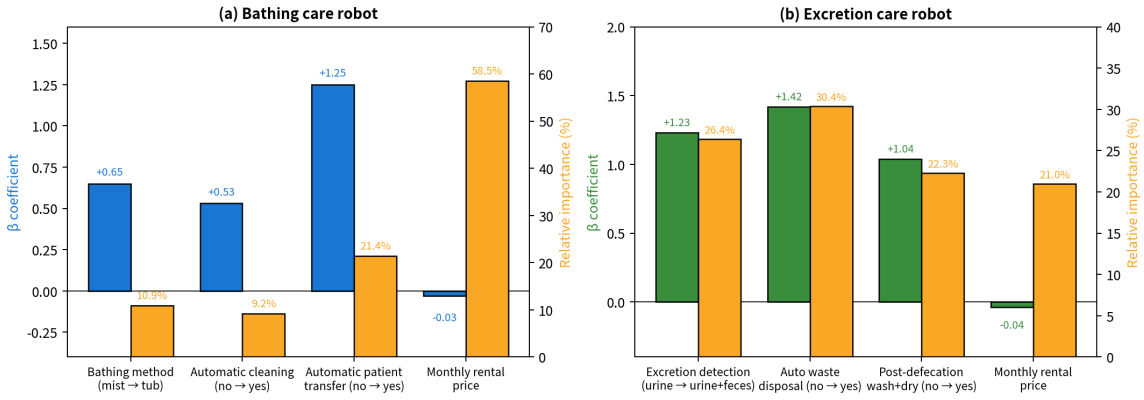

Fig. 1. β coefficients and relative importance for the four attributes of each robot type.

IV. Discussion

For the bathing care robot, automatic patient transfer emerged as the single functional attribute that significantly increased selection probability. This reflects the biomechanical severity of manually moving a dependent adult during bathing, a task associated with a high risk of caregiver low-back and shoulder injury. Monthly rental cost was the dominant driver overall, accounting for more than half of the total relative importance — a finding consistent with the sensitivity of Korean long-term care providers to any out-of-pocket or unreimbursed expense.

For the excretion care robot, all three functional attributes reached statistical significance, and automatic reservoir disposal was the top-ranked attribute in terms of relative importance. Handling excreta is the component of care most likely to trigger disgust responses and to expose the caregiver to infectious agents, so it is not surprising that caregivers place the highest value on the function that fully automates it. Notably, the price sensitivity of the excretion care robot (21.0%) was lower than that of the bathing care robot (58.5%), suggesting that caregivers are willing to tolerate a higher price point in exchange for hygiene automation.

V. Conclusion

This DCE demonstrated that professional caregivers prioritise different attributes for different robot categories: physical-transfer support for bathing care robots, and hygiene automation for excretion care robots. Price sensitivity is high in both cases, but far more pronounced for bathing devices. These findings provide developers with a clear ordering of design priorities and give policy-makers a quantitative basis on which to design reimbursement and rental-subsidy programmes that would accelerate the adoption of care robots in long-term care environments.

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