ASES (Accessory, Solution for Easier Support) Detachable Cap: Enhancing Medication Accessibility for Patients with Hand Muscle and Joint Weakness

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ABSTRACT

The increasing prevalence of hand muscle and joint weakness, particularly among patients with conditions such as rheumatoid arthritis (RA) and systemic lupus erythematosus (SLE), posed significant challenges in medication management. This study aimed to address these challenges by developing and evaluating the ASES (Accessory, Solution for Easier Support) detachable cap, an ergonomic innovation designed to facilitate the opening and handling of medication bottles. The research employed a quasi-experimental post-test-only design, involving 20 participants aged 18 and above with hand muscle and joint weakness, residing in Koronadal City. The ASES detachable cap was assessed through torque and tear resistance tests to evaluate its physical properties, and a survey questionnaire measured patient satisfaction and convenience. Results indicated a significant reduction in the force required to open medication bottles, with mean torque values decreasing from 4.78 N-m to 1.71 N-m. The tear resistance test demonstrated high durability, with a mean tear strength of 20.49 N/mm². Participants reported high levels of satisfaction and convenience, with overall mean scores of 4.37 and 4.08, respectively. The study concluded that the ASES detachable cap effectively enhances medication accessibility and management for patients with hand muscle and joint weakness, improving their independence and quality of life.

Keywords- ASES detachable cap, accessibility, assistive technology, ergonomic design, hand muscle and joint weakness, medication packaging, torque test, tear resistance test, patient satisfaction, convenience, quasi-experimental study.

INTRODUCTION

The increasing prevalence of hand muscle and joint weakness poses a critical challenge in daily activities, particularly in medication management. Patients with rheumatoid arthritis (RA) and systemic lupus erythematosus (SLE) often experience pain, joint stiffness, and limited grip strength, making it difficult to open medication containers (Mikuls et al., 2020; Cano-Garcia, 2024). Elderly populations are especially affected, with reduced dexterity and declining grip strength further limiting their independence (Butler et al., 2019; Alghadir et al., 2016). Those with myoneural disorders face additional barriers due to disrupted nerve-muscle coordination, impacting fine motor control (Omar et al., 2023). Other conditions like osteoarthritis, tendonitis, and neuropathy result in pain, numbness, and weakness that worsen these challenges (Yaseen, 2024; Donaldson et al., 2023; Hudson, 2023; Castelli et al., 2020). These challenges not only hinder their ability to manage their medications effectively but can also contribute to a decrease in overall independence and quality of life (Ma et al., 2021).

According to the World Health Organization (WHO), approximately 1.71 billion people globally suffer from musculoskeletal conditions, which include RA and SLE (WHO, 2022). Nationally, the prevalence of inflammatory rheumatic diseases (IRDs) among Filipino patients like SLE was 41.4%, and for RA it was 15.2% (Zamora et al., 2023). However, there is currently no available data in any local articles or journals about the prevalence of these diseases within Koronadal City, South Cotabato. To address this gap, the researchers gathered data from different hospitals and clinics in Koronadal City for the year 2024. The results revealed that there were 3,032 patients diagnosed with musculoskeletal conditions, 2,298 with neuropathy, 109 with tendonitis/tendon injury, 83 with osteoarthritis, 55 with myoneural disorders, 39 with hand fractures, 36 with RA, and 8 with SLE. These findings underscore the high local prevalence and emphasize the need for solutions that support patient autonomy in medication use.

In response, this study proposed the ASES (Accessory, Solution for Easier Support) detachable medication cap—an ergonomic innovation designed to ease the opening and handling of medication bottles. Research has shown that assistive devices can enhance the independence of patients with hand impairments, empowering them to manage their medication more effectively (Islam, 2024). This study aimed to provide an innovative ergonomic solution tailored for patients with hand muscle and joint weakness. By focusing on the design and evaluation of a detachable medication cap, the research seeks to empower individuals, enabling them to independently manage their medication needs without requiring assistance. The expected outcome of this study is to contribute to the social value by promoting autonomy and enhancing the quality of life for affected patients. The dissemination plan included publishing the research paper in academic journals to share the findings with the broader scientific community and healthcare professionals, further expanding its impact.

MATERIALS AND METHODS

Research Design

In conducting this study, the researchers employed a quasi-experimental research design. An initial pilot test was conducted to validate procedures, followed by a product evaluation phase. This design allowed the assessment of the interventions' effects without random assignment (Ary et al., 2018) making it ideal for studying the impact of the ASES (Accessory, Solution for Easier Support) Detachable Cap on the medication accessibility for individuals with muscle weakness aged 18 and above.

Participants used the ASES (Accessory, Solution for Easier Support) Detachable Cap to assess the subjective measures of ease of use and physical effort. The data from the post-test assessments were then evaluated on the changes in physical effort, comfort, and user satisfaction. Subjective evaluations (Likert Scales) were used to capture the effects of the ASES Detachable Cap on medication accessibility.

Research Locale

This research was conducted in Koronadal City, located in the northern part of South Cotabato Province in Southern Mindanao. Koronadal was selected as the study site due to its roles as the administrative center and capital of South Cotabato, as well as significance as a regional hub for commerce, culture, and population. It is known as the regional center, Koronadal supports various agricultural and commercial activities, which play a crucial role in the local economy and act as drivers of regional development (Philippines Statistics Authority, 2022).

Population and Sampling

The study involved individuals aged 18 and above who suffer from hand muscle and joint weakness and resided in Koronadal City. For inclusion, participants have met the following criteria: being at least 18 years old, living in Koronadal City, and experiencing conditions such as myoneural disorders, rheumatoid arthritis, osteoarthritis, systemic lupus erythematosus, tendonitis/tendon injury, or neuropathy. Additionally, participants must be recently diagnosed with one of these conditions, willingly consent to join the study, and have their condition verified by an orthopedic surgeon and a physical therapist. They should also be users, past or present, of medication that requires twisting or gripping packaging and be available for the study's post-test phase. Conversely, the study excluded individuals who were under 18 years of age, do not live in Koronadal City, or do not have hand muscle and joint weakness. Exclusion also applied to those who were not recently diagnosed with the condition, decline to participate, do not have their condition confirmed by a healthcare professional, do not use medication requiring such packaging, or were not available for the post-test phase.

A purposive sampling design was used as the sampling method for this study. According to the article by Dr. Renu Bisht (2024), purposive sampling is a non-randomized sampling technique that selects sampling units based on certain criteria. It is a type of non-probability approach in which the researcher chooses a sample

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(person, cases, or events) based on their assessment that it would fit the study's objectives. This method enabled the researchers to find participants who voluntarily agree to participate in the study, ensuring that they were specifically those who met the criteria related to the objectives of the research. According to Austin and Steyerberg's (2017) study, experimental studies should have at least 20 participants in order to accurately assess the effects of the intervention and ensure a sufficient sample size for reliable findings. Therefore, researchers aimed to find at least 20 qualified participants for this study.

Research Instrument

Prior to the conduct of the study, pilot testing was conducted. The researcher utilized a validated self-made survey questionnaire that was used to collect data from participants. The content of the survey was validated by an assigned expert validator to ensure its validity and reliability. The survey was administered to assess product acceptability.

The post-test involved participants using the ASES detachable Cap for a week. The survey included Likert scale to measure the satisfaction and ease of usage, with statements like "The ASES Detachable Cap is easy to use," rated from 1 (Strongly disagree) to 5 (Strongly agree). A higher rating indicates greater ease of use.

Development of ASES Detachable Cap

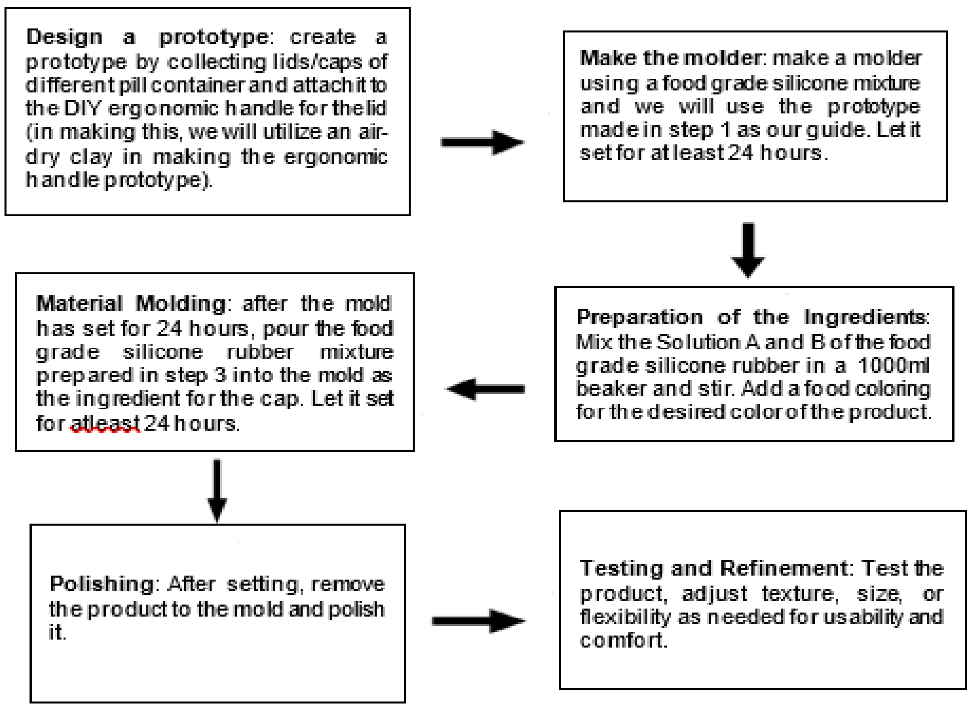

Figure 4: Procedure to Develop ASES (Accessory, Solution for Easier Support) Detachable Cap

Standard Operating Procedures

A. Force Test (Torque Test)

Preparation of the Sample:

Ensure the ASES detachable cap is in its original or operational condition.

Clean the sample, if necessary - to remove debris or contaminants that could affect the test results.

Test Setup:

Use a DIY Torque testing machine made by Engr. Joery C. Estember to open and close bottles to a specific torque level.

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The sample is typically installed using a 8 ply yarn into a fixture or corresponding part (e.g., a nut, bottle, or container) that simulates real-life usage conditions.

Torque Application:

Apply a continuous rotational force to the sample using the DIY torque testing machine, while measuring the torque in Newton-meters (N-m).

For torque to failure, continue applying force until the component breaks, deforms, or reaches the failure point.

For torque to engage or tighten, the tester measures the torque required to turn the component from a starting position to a certain point, often until it reaches a certain level of tightness.

Data Collection:

Record the peak torque value (the highest torque applied) and any intermediate values during the test. If applicable, record the point at which failure occurs.

For multiple tests, perform the procedure on several samples to ensure consistency and accuracy in results.

Post-Test Inspection:

Inspect the sample for signs of damage, such as yarn stripping, cracking, or deformation.

If the component is meant to be reusable, measure its functionality after testing (e.g., can it still be screwed on and off without issue?).

Physical Integrity Criteria:

Torque Resistance: Should require 0.5 N-m to 1.5 N-m to open/close securely and should withstand 1.5 N-m to 3.0 N-m before damage.

Grip and Ergonomics: Requires no more than 2-4 kg of force and should have textured surfaces for easy grip and comfort.

User Ease: Should be easy to use for individuals with joint or muscle weakness, with clear visual or tactile indicators.

A licensed engineer performed a torque test on the ASES detachable cap, made of food-grade silicone, using a DIY torque testing machine, following ASTM D7860-14 standards. This standard measured the torque retention properties of various container/continuous thread closure systems, suitable for both child-resistant and non-child-resistant packaging. It ensured that packages were secure yet accessible, balancing child safety with ease of opening for adults. Adhering to this standard helped reduce product tampering risk and ensures compliance with safety regulations, thereby protecting consumers and enhancing product credibility (ASTM, 2022).

According to ASTM E2624-15 which outlined torque calibration procedures, it is recommended to conduct a minimum of three trials to ensure the reliability and accuracy of the test results (ASTM, 2015). Therefore, it should conduct at least three trials for your torque test to ensure reliable and consistent results.

Durability Test (Tear Resistance Test)

ASES Detachable Cap Preparation

Prepare ASES Detachable Cap for testing.

Ensure ASES Detachable Cap are free from defects and conform to specified thickness.

Initial Cut: Make a small cut at the designated notch of the specimen to initiate the tear

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Setup of Universal Testing Machine (UTM)

Ensure the UTM is calibrated and in good condition.

Attach grips such as pneumatic side action or self-tightening roller grips to the UTM to hold the specimen securely.

Mounting the Specimen: Place the specimen in the grips of the UTM, ensuring it is aligned correctly.

Set the UTM to apply a tensile load at a constant rate of extension.

Start the UTM to pull the specimen apart until it tears completely.

Observation and Measurement

Record the force required to initiate and propagate the tear.

Observe the tear path and note any irregularities.

CALCULATION

Calculate tear strength as: $\text{Tear Strength} = \text{Force at Tear (N)}/\text{Thickness of the Material (mm}^2)$

Express the tear strength in units of force per unit thickness (e.g., N/mm^2).

Documentation

8.1 Record all data, including the force, tear path, and any observations about the failure mode.

8.2 Compare the results to relevant standards or specifications to determine if the material meets the required durability criteria.

Physical Integrity Criteria:

Range: 5 to 55 N/mm^2.

Flexibility and Elasticity: The cap should maintain flexibility and elasticity over a wide temperature range, typically from -40°C to 230°C, to ensure it can handle various environmental conditions without cracking or becoming brittle.

Compression Set: This is the material's ability to return to its original thickness after being compressed. A low compression set is desirable to maintain a good seal over time. For food-grade silicone, a typical value is 5- 25% after 22 hours at 175°C.

A licensed engineer conducted the tear resistance test on the ASES detachable cap made with food-grade silicone rubber using a Universal Testing Machine (UTM) and by following the ASTM D624 standard. The ASTM D624 standard is commonly used for determining the tear strength of vulcanized rubber and thermoplastic elastomers, which includes silicone rubber. This standard outlined the procedures for measuring the resistance of these materials to tearing action, which is crucial for assessing their durability and performance in various applications (ASTM, 2020). ASTM D624 provided similar results to ISO 34, another common test that measures the tear strength of elastomeric materials. Though the ASTM and ISO organizations who are currently working toward diminishing the differences between these two standards, the results cannot yet be considered comparable, and care must be taken to ensure the correct test standards being used for a given application. ASTM D624 is intended to measure tearing strength only (Thackeray, 2023).

According to the ASTM D624 standard for determining the tear strength of vulcanized rubber and thermoplastic elastomers, it is recommended to conduct a minimum of five trials to ensure the reliability and accuracy of the

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test results (ASTM, 2020). This number of trials helps account for variability and provides a statistically significant average.

Data Gathering Procedure

Before conducting the study, the researchers provided an informed consent form. An intent letter was sent to the selected healthcare facility requesting approval to conduct the study. Upon approval, participants were selected based on the recommendations of the orthopedic surgeon (a specialist in bones and joints) and the physical therapist.

The participants were informed about the study's purpose, objectives, and procedures, and each gave informed consent to participate. ASES (Accessory, Solution for Easier Support) Detachable Caps were provided to the participants and demonstrated twice—first by the researchers, and then by the physical therapist. One week after the intervention, a product evaluation was conducted to assess the outcomes. Patient responses regarding satisfaction and convenience were explained individually by the orthopedic surgeon and the physical therapist. These responses were documented by the researchers, providing both qualitative and quantitative data to evaluate the effectiveness of the cap in this patient group.

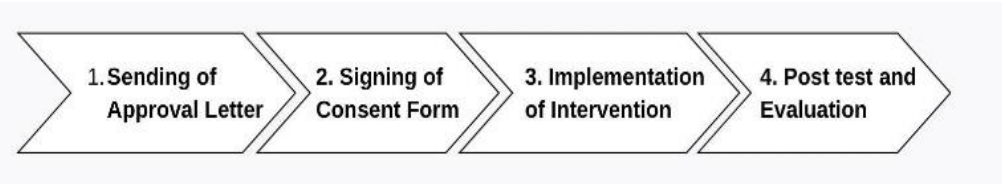

Figure 5: Data Gathering Procedure

Statistical Analysis

The statistical analysis for the study on the ASES (Accessory, Solution for Easier Support) detachable cap: enhancing medication accessibility for patients with hand muscle and joint weakness addressed the research questions using descriptive statistical methods. For the physical properties, the Force Test (Torque Test) will measure the rotational force required to open and close the ASES detachable cap using the formula: Torque = Force (N) × Distance (M). The mean torque value were be calculated to assess the consistency and ease of use of the cap. Additionally, the Durability Test (Tear Resistance Test) measured the force required to initiate and propagate a tear in the material, calculated using the formula: Tear Strength = Force (N) / Thickness of the material (mm^2). The mean tear resistance were determined to gauge the material's durability and reliability. In terms of patient indicators, data were collected using a 5-point Likert scale to assess patient satisfaction and convenience. For each of these indicators, the mean were computed to provide an overview of patient performance after the intervention. This approach ensured a clear understanding of the post-intervention conditions (Field, 2018).

RESULTS AND DISCUSSION

This chapter presented a detailed analysis of the data obtained from the study on the ASES (Accessory, Solution for Easier Support) detachable cap, aimed at enhancing medication accessibility for patients with hand muscle and joint weakness. Descriptive statistical methods were done to answer the specific questions of this study.

Table 1 Torque Test Results

Trials	Results		Interpretation	Remarks
	Before the use of ASES Detachable Cap	**After the use of ASES Detachable Cap**		
Trial 1	4.22 N-m	1.79 N-m	Within the criteria range	Passed
Trial 2	7.38 N-m	2.28 N-m	Within the criteria range	Passed

Trial 3	2.74 N-m	1.07 N-m	Within the criteria range	Passed
Mean	**4.78 N-m**	**1.71 N-m**	**Within the criteria range**	**Passed**

The torque test results shown significant improvements in the ease of opening and closing medication bottles after utilizing the ASES detachable cap. Initially, the torque required to open/close the bottles was considerably high, with values of 4.22 N-m, 7.38 N-m, and 2.74 N-m across three trials, resulting in an overall mean of 4.78 N-m. These values exceeded the recommended range of 0.5 N-m to 1.5 N-m to open/close securely and withstand 1.5 N-m to 3.0 N-m before damage, indicating difficulty and potential risk of damage. However, after using the ASES detachable cap, the torque required decreased substantially to 1.79 N-m, 2.28 N-m, and 1.07 N-m in the respective trials, with an overall mean of 1.71 N-m. These post-utilization values fall within the criteria range, demonstrating improved ease of use and compliance with physical integrity criteria. The criteria for torque resistance, which require 0.5 N-m to 1.5 N-m to open/close securely and withstand 1.5 N-m to 3.0 N-m before damage, were met after using the cap, as all post-utilization values were within the range and withstood the criteria before damage. These results are supported by ASTM standards such as ASTM D7860-14 and ASTM E2624-15, which outline the methods for measuring torque retention and calibration of testing machines (ASTM, 2022; ASTM International, 2015).

Further supporting these results, Barbosa et al. (2021) emphasized in their systematic review that assistive devices for upper limb rehabilitation must prioritize ergonomic design and torque reduction to improve usability and reduce strain in patients with neuromuscular impairments. Their findings highlight that mechanical assistive tools, even without complex electronics, can significantly enhance functional independence when designed with torque-limiting features. Similarly, a 2018 review by Varghese et al. on upper-limb exoskeletons for rehabilitation concluded that minimizing torque and resistance in assistive devices is essential for improving user compliance and reducing fatigue during repetitive tasks. Additionally, a 2023 study on home-based mechatronic rehabilitation systems by Forbrigger et al. reinforced that torque optimization in assistive tools directly correlates with improved patient satisfaction and reduced physical effort. These studies collectively validate the ASES detachable cap's effectiveness in reducing torque demands and enhancing medication accessibility for individuals with hand muscle and joint weakness.

Table 2 Tear Resistance Test Results

Trials	Results	Interpretation	Remarks
Trial 1	19.75 N/mm²	Within the criteria range	Passed
Trial 2	19.09 N/mm²	Within the criteria range	Passed
Trial 3	20.27 N/mm²	Within the criteria range	Passed
Trial 4	20.64 N/mm²	Within the criteria range	Passed
Trial 5	22.68 N/mm²	Within the criteria range	Passed
Mean	**20.49 N/mm²**	**Within the criteria range**	**Passed**

The tear resistance test results for the ASES detachable cap material shown its high durability and reliability across five trials. The tear resistance values were calculated as 19.75 N/mm², 19.09 N/mm², 20.27 N/mm², 20.64 N/mm², and 22.68 N/mm² for Trials 1 through 5, respectively. These values fall within the required range of 5 to 55 N/mm², indicating that the material meets the criteria for tear resistance and can withstand significant force before damage. The mean tensile strength was found to be 20.49 N/mm² reflecting consistent performance across all trials. These findings highlight the effectiveness of the ASES detachable cap in providing a durable and reliable solution for medication management, ensuring that the material can endure the physical demands of regular use without compromising its integrity. The consistent tear resistance values across multiple trials underscored the cap's ability to maintain its structural integrity under varying conditions, making it a dependable choice for patients with hand muscle and joint weakness. These results are supported by ASTM D624, which specifies the standard test method for tear strength of conventional vulcanized rubber and thermoplastic elastomers (ASTM, 2020).

Further supporting these findings, Qian and Jiang (2023) compared ASTM and ISO protocols for testing tear strength in medical-grade silicone. Their study confirmed that silicone rubber consistently meets durability standards required for assistive and wearable medical devices, particularly under repetitive-use conditions. Additionally, Li et al. (2025) conducted a study on the machinability and performance of medical-grade materials and emphasized the importance of selecting materials with high mechanical strength and fatigue resistance for biomedical applications, including those subjected to frequent handling. These studies validate the ASES cap's material choice and its performance in tear resistance testing.

Table 3 Overall Mean on Level of Perception of Patient Satisfaction on Ases Detachable Cap

Items		**Perception**	
	Mean	**Description**	**Verbal Interpretation**
1. I am pleased with how well the ASES detachable cap works.	4.45	Strongly Agree	**Highly Satisfied**
2. My everyday life has been improved by the ASES detachable cap. (Use period: 7 days)	4.05	Agree	**Satisfied**
3. The ASES detachable cap helps me manage my medication on my own.	4.35	Strongly Agree	**Highly Satisfied**
4. The ASES detachable cap has lessened my frustrations with opening medication bottles.	4.40	Strongly Agree	**Highly Satisfied**
5. I feel more confident in managing my medication with the help of ASES detachable cap.	4.50	Strongly Agree	**Highly Satisfied**
6. I find the design of the ASES detachable cap attractive.	4.10	Agree	**Satisfied**
7. The ASES detachable cap performs consistently and reliably.	4.65	Strongly Agree	**Highly Satisfied**
8. The ASES detachable cap has made it easier for me to open medication bottles without causing hand pain.	4.00	Agree	**Satisfied**
9. I would recommend the ASES detachable cap to others	4.60	Strongly Agree	**Highly Satisfied**
10. Overall, I am satisfied with the quality and performance of ASES detachable cap	4.60	Strongly Agree	**Highly Satisfied**
Overall Mean:	**4.37**	**Strongly Agree**	**Highly Satisfied**

The questionnaire results indicated a high level of patient satisfaction with the ASES detachable cap, reflected in an overall mean score of 4.37. Users strongly agreed that the cap works well and helps them manage their medication independently, with mean scores of 4.45 and 4.35, respectively. The cap significantly improved users' daily lives (mean = 4.05) and reduced frustrations associated with opening medication bottles (mean = 4.40). Additionally, users felt more confident in managing their medication with the cap's help (mean = 4.50) and found it to be consistently reliable (mean = 4.65). The cap's design was also appreciated, with users agreeing that it is attractive (mean = 4.10). The high recommendation score (mean = 4.60) further emphasized the cap's perceived value and effectiveness. Overall, the positive feedback highlighted the cap's potential to enhance medication management and improve the daily lives of patients. These findings were supported by studies on patient satisfaction questionnaires, such as the revised Patient Satisfaction Questionnaire (PSQ-R), which has demonstrated validity and reliability in assessing patient satisfaction (Niu et al., 2024; CAHPS, 2024). The PSQ-R study emphasized the importance of healthcare service quality and medical staff skills in enhancing patient satisfaction, which aligns with the positive perceptions of the ASES detachable cap in improving medication management (Niu et al., 2024).

These results are further supported by Fernández-Batanero et al. (2022), who conducted a systematic review on assistive technologies and found that user satisfaction is significantly influenced by ease of use, perceived autonomy, and the ability to reduce physical effort. Similarly, Donnelly et al. (2023), in their study published in The Patient – Patient-Centered Outcomes Research, emphasized that satisfaction with assistive technologies is closely tied to how well the device integrates into daily routines and supports independence. Additionally, Haltaufderheide et al. (2023) noted that users of socially assistive devices report higher satisfaction when the tools are intuitive and reduce reliance on caregivers, which aligns with the ASES cap's design and user feedback.

Table 4 Overall Mean on Level of Perception of Patient Convenience on Ases Detachable Cap

Items		**Perception**	
	Mean	**Description**	**Verbal Interpretation**
1. The ASES detachable cap is easy to attach and detach from the medication bottles	3.65	Agree	**Convenient**
2. The ASES detachable cap is easy to use.	4	Agree	**Convenient**
3. The ASES detachable cap makes it easier to open my medication bottles.	4.10	Agree	**Convenient**
4. I find the ASES detachable cap's design comfortable to handle.	3.60	Agree	**Convenient**
5. The design of the ASES detachable cap allows for an easy grip.	3.80	Agree	**Convenient**
6. The ASES detachable cap is light and easy to carry.	4	Agree	**Convenient**
7. The ASES detachable cap's ergonomic design reduces strain on my hands when opening my medication bottles.	4.10	Agree	**Convenient**
8. The ASES detachable cap is easy to store when not in use.	4.45	Strongly Agree	**Very Convenient**
9. Using the ASES detachable cap has made my medication routine more convenient.	4.10	Agree	**Convenient**
10. Overall, the ASES detachable cap has exceeded my expectations for its convenience.	4.30	Strongly Agree	**Very Convenient**
Overall Mean:	**4.08**	**Agree**	**Convenient**

The questionnaire results shown that users found the ASES detachable cap to be generally convenient, with an overall mean score of 4.08. Users agreed that the cap is easy to attach and detach from medication bottles (mean = 3.65) and easy to use (mean = 4.00). The cap's design was found comfortable to handle (mean = 3.60) and allowed for an easy grip (mean = 3.80). The ergonomic design reduced hand strain when opening medication bottles (mean = 4.10), and the cap was easy to store when not in use (mean = 4.45). Users felt that the cap made their medication routine more convenient (mean = 4.10) and exceeded their expectations for convenience (mean

= 4.30). These results underscored the cap's potential to simplify medication management and enhance the overall convenience for patients. The findings aligned with the CAHPS Patient Experience Surveys, which emphasize the importance of ease of use and patient convenience in healthcare products (CAHPS, 2024). The CAHPS surveys highlighted the significance of patient experiences with healthcare services, which supported the positive feedback on the convenience of the ASES detachable cap in improving medication routines (CAHPS, 2024).

These findings are further supported by Soar et al. (2020), who reviewed assistive technologies for older adults and found that ease of use, reliability, and support for daily living were among the most important factors influencing adoption and perceived convenience. Their study emphasized that assistive tools that reduce complexity and integrate seamlessly into daily routines are more likely to be accepted and consistently used. Additionally, Haltaufderheide et al. (2023) conducted a systematic review on socially assistive devices and concluded that intuitive design and reduced need for external help significantly enhance autonomy and convenience for users with physical impairments. These findings reinforce the conclusion that the ASES detachable cap's ergonomic and user-friendly design contributes meaningfully to patient convenience and independence.

CONCLUSION

In light of the findings, the researchers concluded that the majority of the participants reported high levels of satisfaction and convenience with the ASES detachable cap. The torque test results indicated that the force required to open and close medication bottles significantly decreased, with mean torque values falling within the recommended range. The tear resistance test demonstrated that the cap material was highly durable, consistently meeting the required standards. The study observed that the primary challenges faced by participants with hand muscle and joint weakness were effectively addressed by the ASES detachable cap, which reduced physical strain and improved medication management. Overall, the findings revealed that the ASES detachable cap significantly improves medication accessibility and convenience for patients with hand muscle and joint weakness.

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