Analysis of Supportive Furniture Behaviors in Age-Friendly Residential Environments

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Abstract

Older adults often require additional support when performing daily activities such as standing up, sitting down, and posture transitions due to age-related declines in balance and muscle strength. However, the acceptance of medical-style handrails in residential environments remains low. In everyday life, older adults tend to intuitively rely on nearby household furniture as sources of support. This study employs scenario-based observation to examine the actual use of residential furniture as substitutes for handrail functions. The participants consisted of 5 older adults who were observed during sit-to-stand and posture transition activities in simulated daily living scenarios. The locations of support, types of furniture used, and modes of interaction were documented. In addition, expert questionnaire feedback was collected to evaluate the potential risks associated with using furniture as support. The results indicate that when performing sit-to-stand or posture transition activities near seating areas, older adults frequently used adjacent furniture, such as chair sides and table edges, as immediate support, thereby functioning similarly to handrails. These furniture elements were often selected due to their proximity and intuitive usability; however, their structural characteristics and dimensions are not specifically designed to provide support and may therefore pose potential safety risks. The findings reflect older adults' real-life residential behaviors and may serve as preliminary references for future age-friendly residential space planning and furniture-integrated assistive design.

Keywords: older adults, furniture support behavior, aging-in-place housing, usage behavior, aging society

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Introduction

Aging Trends

With the extension of average life expectancy and the continuous decline in birth rates in contemporary society, demographic structures have gradually shifted, making population aging a major global social issue. Taiwan is also expected to officially enter a super-aged society by 2026, bringing the maintenance of older adults' quality of life and healthy aging to the forefront of policy and academic concern. In response to the challenges posed by population aging, the World Health Organization has proposed concepts such as active aging, healthy aging, and aging in place, which have gradually become key objectives in aging-related policies and practical initiatives. These concepts emphasize enabling older adults to maintain independent living in familiar environments, delay functional decline, and ultimately realize the vision of aging in place.

Elderly Home Living Environment

As people age, older adults commonly experience physical and behavioral declines such as reduced muscle strength and diminished balance, which in turn affect the safety and stability of their activities of daily living. In Taiwan, the housing stock is generally characterized by an aging building profile, with many existing residential structures and facilities gradually deteriorating over time. As a result, the overall level of environmental support within the home is often insufficient to adequately respond to the living support needs that arise from age-related functional decline among older adults.

Furniture as Informal Support and Assistive Use

Assistive devices, which are commonly used as supportive tools for older adults, often present a medicalized appearance that leads to issues of stigmatization. This medicalized image may cause psychological reluctance among some older adults, thereby reducing their willingness to use such devices. Under these circumstances, furniture in everyday living environments gradually assumes the role of informal assistive devices. When appropriate support facilities are lacking within the home, older adults frequently rely on surrounding existing furniture as sources of support during daily activities, such as grasping table edges, chair backs, or cabinet edges to assist with posture transitions or to maintain bodily stability. However, these furniture elements are not originally designed for load-bearing or supportive purposes. Their structural forms, dimensional configurations, and load-bearing characteristics may therefore involve potential safety risks, yet they continue to be frequently used in daily life. This phenomenon warrants further investigation.

Research Purpose

Based on the aforementioned research background, this study aims to investigate the daily home-living behaviors of older adults through a scenario-based observation method, with a particular focus on their use of furniture as support during posture transitions. The study will identify furniture types that are most frequently relied upon for support and analyze their support locations, relevant dimensional characteristics, and modes of use. These findings will then be compared with the functional design principles and dimensional characteristics of handrails used in assistive devices. Finally, through expert evaluation, this study will examine the supportive potential, safety considerations, and potential risks of furniture when used as a

support interface, providing reference guidelines for subsequent furniture design for older adults and applications of assistive device–furniture integration.

Literature Review

Lifestyles and Behaviors of Older Adults

Aging-in-Place

In response to global population aging, the World Health Organization (WHO) has proposed concepts such as active ageing, healthy ageing, and aging in place, emphasizing the importance of maintaining functional ability and independent living in familiar environments (WHO, 2002; WHO, 2015; WHO, 2020).

In Taiwan, approximately 90% of older adults prefer to continue living in their original homes rather than relocate to institutional care facilities (Ministry of Health and Welfare, 2024), highlighting the importance of residential environments in supporting aging in place.

Daily Living Behaviors of Older Adults

Previous studies have indicated that the living room is one of the primary activity spaces for older adults and accommodates a wide range of daily behaviors (Cheng, 2018). In many residential environments, the living room and dining area are also spatially connected and represent major areas for daily activities.

As physical function declines with age, posture transitions and walking may become increasingly difficult, leading older adults to rely more on surrounding environmental elements for support during daily activities (Lee, 2006).

Residential Environments of Older Adults

Although homeownership rates among older adults in Taiwan remain high, many existing residential environments still lack sufficient environmental support for aging-related functional decline. Previous studies have indicated that aging housing conditions and residential spaces not originally designed for older adults may increase difficulties and safety risks during daily activities (Chen & Chang, 2023; Chung & Chou, 2021).

As physical function gradually declines with age, older adults may increasingly rely on surrounding environmental elements for support during daily movements and posture transitions (Hsieh, 2021).

Assistive Devices and Handrail Support

Assistive Devices

Previous studies have shown that assistive devices can improve safety, mobility, and functional performance among older adults (Chang, 2011). However, many assistive devices present a strong medical appearance, which may lead to psychological resistance and reduce willingness to use them (Mao, 2010).

Under these circumstances, household furniture may gradually function as an informal support interface in daily living environments. When formal assistive devices are unavailable or not preferred, older adults may rely on nearby furniture, such as table edges or chair backs, to assist with posture transitions and movement stability.

Handrail Support Characteristics

Handrails are regarded as important support interfaces for posture transitions and walking among older adults, helping improve movement stability and reduce fall risks (Tsai, 2018; Zheng, 2021). Compared to mobile assistive devices, handrails can provide immediate upper-limb support without significantly affecting circulation within residential spaces.

According to the Design Specifications for Accessible and Usable Buildings and Facilities (Ministry of the Interior, 2022), recommended handrail heights are generally between 75–85 cm. Appropriate dimensions and stable support conditions allow users to maintain effective grip and body support during movement and posture transitions.

Aging-Oriented Design and Assistive Furniture Integration

Based on the preceding discussion, conventional assistive devices may evoke psychological resistance due to their medical appearance, while existing residential environments often lack sufficient environmental support for older adults. Under these circumstances, furniture-integrated assistive design may provide supportive functions within familiar living environments while reducing the sense of medicalization (Cheng, 2018).

This design approach also responds to older adults' needs for low-intervention and high-support living assistance within familiar residential settings, serving as an important foundation for subsequent design development and research.

Methodology

This study employed scenario-based observation to examine furniture-based support behaviors among older adults in residential environments. The study focused on how older adults relied on surrounding furniture during posture transitions and daily movements.

After the observational analysis, expert evaluation was conducted to examine potential risks and related design considerations associated with furniture-based support behaviors.

Scope and Participants

This section defines the research participants and the scope of the study, clarifying the observational context and research boundaries that form the basis for subsequent scenario-based observation and data analysis.

Participants

The participants of this study are older adults aged 65 years and above who are able to live independently but experience partial functional decline. Individuals with severe disabilities or those who are long-term bedridden are not included in this study, as the research focuses on

older adults who are still capable of performing daily activities but may require environmental support during posture transitions or mobility.

Spatial Scope

This study was conducted within the residential environments of older adults, focusing on interactions between older adults and household furniture during daily activities and posture transitions.

Research Conditions

This study conducted a full-day scenario-based observation within the existing residential environments of older adults, documenting their daily activities and observing naturally occurring support behaviors under the condition that no formal medical assistive devices were used. This approach allows the study to capture how older adults rely on environmental support in real-life living situations.

Previous studies have indicated that the living room is the space where older adults spend the longest amount of time during the day, excluding sleeping periods. Observations in this study similarly showed that the living room was also the area where participants spent the most time during daily activities. In addition, many contemporary residential layouts adopt open-plan configurations in which the living room and dining area are spatially integrated.

Therefore, in the subsequent analysis, the living room and the combined living–dining area were selected as the primary observational scenarios for examining furniture-based support behaviors.

Scenario-Based Observation

This study employed scenario-based observation to document the daily behaviors of older adults in their residential environments. Through full-day observation, interactions between older adults and household furniture were recorded across different daily situations, with particular attention given to behaviors in which furniture was used as support during posture transitions or walking.

After organizing the observational data, frequently occurring furniture-based support behaviors were identified. Based on the furniture types and associated behavioral scenarios, representative furniture–behavior situations were selected as the analytical scenarios for subsequent expert evaluation.

Data Analysis

The observational data were organized and categorized for analysis based on furniture type, support interface, mode of support, and associated behavioral actions. Through this analytical process, frequently occurring furniture-based support behaviors were identified.

In addition, the observational data were statistically summarized. The height and spatial dimensions of support locations were further examined to illustrate the distribution of furniture use across different behavioral scenarios, providing a basis for subsequent expert evaluation and discussion.

Force Level Classification

Based on observational records of hand–interface interactions, force intensity was categorized into three levels:

Level 1 – Contact / Light Touch
Minimal contact without observable weight-bearing. The interface was lightly touched, primarily for balance confirmation or stabilization awareness.

Level 2 – Partial Support
Partial body weight was transferred to the support interface; however, it was not the primary force-bearing source. This level typically occurred during transitional assistance.

Level 3 – Weight-Bearing Support
The interface bore a substantial portion of body weight and functioned as the primary force-bearing source during posture transitions, often accompanied by clear downward pressing or pushing actions.

Expert Evaluation

After completing the scenario-based observation and preliminary data analysis, expert evaluation was conducted in this study. The evaluation adopted a scenario-based open-ended interview approach. Experts with relevant practical experience were invited to assess the furniture-based support behaviors identified in the observations, focusing on potential risks and possible improvement suggestions.

Expert Participants

The experts invited in this study were required to have professional backgrounds in interior design, construction engineering, or public facility planning in development companies, with more than ten years of relevant practical experience. The experts were expected to provide professional judgments from the perspectives of spatial design and architectural practice regarding older adults' support behaviors during posture transitions and the design conditions of supportive interfaces within residential environments. A total of three experts with relevant professional backgrounds were invited to participate in the interviews.

Evaluation Framework

The expert evaluation framework was developed based on the observational findings and preliminary data analysis of this study. The evaluation focused on furniture-based support behaviors actually used by older adults. Experts were asked to examine the scenarios from the following three perspectives:

1) Potential risks: whether using furniture as support may result in safety issues such as slipping, tipping, or loss of balance.
2) Sources of risk: factors that may lead to these risks, such as furniture structural stability, support height, material characteristics, or usage patterns.
3) Improvement suggestions: possible improvement directions related to furniture design or support positions.

Item Design and Evaluation Method

The expert evaluation was conducted using a scenario-based approach. High-frequency furniture-based support behaviors identified from the observational analysis were translated into specific scenarios and presented to the experts with accompanying illustrations and behavioral descriptions.

The interviews adopted an open-ended response format. Experts were asked to provide their professional opinions regarding potential risks, possible sources of risk, and improvement suggestions for each scenario. The interview content was recorded through audio recordings and written notes, and the collected responses were subsequently organized and analyzed to support the discussion and design implications of this study.

Results

This study documented furniture-based support behaviors among older adults in residential environments through scenario-based observation. A total of 148 support behaviors were recorded and analyzed according to furniture type, behavioral context, support mode, force level, and support interface characteristics.

Participants and Observational Data Overview

Five older adults with independent living ability but partial functional decline participated in this study. Scenario-based observation was conducted within their residential environments, including the living room, dining area, and bedroom.

The observations documented furniture types used for support, support locations, interaction modes, and associated behavioral situations during daily activities and posture transitions.

Distribution of Furniture-Based Support Behaviors

The distribution of furniture-based support behaviors is presented in Table 1.

Table 1
Distribution of Furniture-Based Support Behaviors

Furniture	Frequency (n)	Percentage (%)
Dining table	55	37.16
Sofa	41	27.70
Bed	37	25.00
Coffee table	6	4.05
Chair	6	4.05
Dining chair	3	2.03
Total	148	100

As shown in Table 1, dining tables, sofas, and beds accounted for the majority of observed support behaviors, representing 89.86% of all recorded interactions.

Distribution of Behavior Types

The distribution of behavior types in furniture-based support behaviors is presented in Table 2.

Table 2
Distribution of Behavior Types in Furniture-Based Support Behaviors

Behavior Type	Frequency (n)	Percentage (%)
Walking	39	26.35%
Sit-to-Stand	34	22.97%
Stand-to-Sit	27	18.24%
Seat Transfer	15	10.14%
Turning	12	8.11%
Lie-to-Sit	8	5.41%
Sit-to-Lie	7	4.73%
Lying Repositioning	4	2.70%
Changing Shoes	2	1.35%
Total	**148**	**100%**

As shown in Table 2, walking, sit-to-stand, and stand-to-sit were the most frequently observed behavioral scenarios.

Modes of Support and Force Characteristics

The distribution of support modes is presented in Table 3.

Table 3
Distribution of Support Modes in Furniture-Based Support Behaviors

Support Mode	Frequency (n)	Percentage (%)
Grip	8	5.41%
Press	83	56.08%
Pull	2	1.35%
Support	55	37.16%
Total	**148**	**100%**

As shown in Table 3, pressing was the most common support mode, followed by supportive holding.

The relationship between support mode and force level is presented in Table 4 and Table 5.

Table 4
Relationship Between Support Mode and Force Level (Frequency)

Support Mode	Level 3	Level 2	Level 1	Total
Grip	8	0	0	8
Press	74	9	0	83
Pull	2	0	0	2
Support	0	39	16	55
Total	**84**	**48**	**16**	**148**

Table 5
Percentage Distribution of Support Modes Across Force Levels

Support Mode	Level 3	Level 2	Level 1
Grip	9.52%	0%	0%
Press	88.1%	18.75%	0%
Pull	2.38%	0%	0%
Support	0%	81.25%	100%
Total	**100%**	**100%**	**100%**

The results indicate that high-force support behaviors were primarily associated with pressing actions, whereas low-force support behaviors mainly involved supportive holding.

Support Interface Height Characteristics

The height distribution of frequently used furniture support interfaces is presented in Table 6.

Table 6
Height Characteristics of Furniture Support Interfaces

Furniture	Support Interface	Height Range (cm)
Dining table	Table surface	75–85
Sofa	Seat surface	38–45
Sofa	Armrest	55–60
Bed	Bed surface	30–50
Coffee table	Table surface	50–55
Chair	Seat surface	30
Chair	Armrest	50

Overall, the heights of support interfaces involved in high-frequency support behaviors were distributed across different vertical ranges, suggesting that furniture elements of varying heights were used as support interfaces under different behavioral contexts.

Expert Evaluation of Furniture-Based Support Behaviors

Based on the preliminary behavioral observations, several common scenarios in which older adults relied on household furniture for support were identified. These scenarios served as the basis for the expert evaluation. The evaluation scenarios primarily focused on activities occurring in living room and dining areas, as these spaces represent major residential areas where older adults spend extended periods of time and frequently perform posture transitions during daily activities.

Scenario illustrations presenting different combinations of furniture types and behavioral actions were used to facilitate the expert evaluation. Experts from relevant fields were invited to review the scenarios and provide professional insights regarding the potential risks, sources of risk, and possible improvement strategies when furniture or spatial elements were used as support interfaces.

A summary of expert feedback regarding furniture-based support behaviors is presented in Table 7.

Table 7

Summary of Expert Feedback on Furniture-Based Support Behaviors

Element / Furniture	Behavior Scenario	Risk Source	Potential Risk	Design Improvement Suggestion
Chair	Sit-to-Stand	Seat height too low; insufficient armrest support; chair instability	Difficulty standing; chair sliding or tipping	Increase seat height; add stable armrests; improve stability
Sofa	Walking Support	Support height too low; difficult to grasp; discontinuous support surface	Unstable support during walking; loss of balance	Adjust support height; provide graspable armrest; continuous support surface
Sofa	Sit-to-Stand	Seat too low; cushion too soft; lack of armrests	Difficulty standing; forward imbalance	Add armrests; medium cushion firmness; adjust seat height
Sofa	Lie-to-Sit Transition	Backrest height insufficient; cushion too soft; insufficient support	Difficulty applying force; unstable posture	Adjust backrest height; medium cushion firmness; add support points
Coffee Table	Walking Support	Support height too low; glass surface too slippery; sharp edges	Hand slipping; collision injuries	Adjust height; anti-slip surface; rounded edges
Coffee Table	Stand-to-Sit	Uneven support height; slippery surface; sharp edges	Hand slipping; unstable support	Unify support height; anti-slip surface; rounded edges
Dining Table	Walking Support	Hard to grasp; insufficient stability; discontinuous support surface	Unstable support; collision risk	Provide graspable edge; improve stability
Dining Table	Sit-to-Stand	Furniture not designed for support; lack of graspable edge	Insufficient force application; collision risk	Add graspable edge; reinforce table stability; add assistive support

The summarized results indicate that furniture frequently used as support is mainly associated with structural stability, appropriate support height, and safe grasping interfaces.

The categorization of furniture-related design factors identified from expert feedback is presented in Table 8.

Table 8

Categorization of Furniture Design Factors Identified From Expert Feedback

Element / Furniture	Support Interface (Graspability / Height)	Furniture Dimension	Stability	Surface Friction	Edge Safety
Chair	✓	✓	✓		
Sofa	✓	✓			
Coffee Table	✓			✓	✓
Dining Table	✓		✓		✓

The results indicate that furniture-based support behaviors may be influenced by design conditions related to support interfaces, stability, and safety.

Discussion

In residential environments, household furniture may serve not only its original functional purposes but also act as a source of physical support during daily posture transitions for older adults. This phenomenon reflects the behavioral adaptation of older adults to their living environments, where nearby furniture is often used intuitively as support during movements such as standing up, sitting down, or maintaining balance while walking.

Because furniture is readily accessible and located along daily activity routes, older adults may naturally rely on these elements as convenient support interfaces when formal assistive devices such as handrails are not available.

Furniture as Informal Support in Residential Environments

The findings of this study suggest that household furniture may function as an informal source of support in residential environments for older adults. Observational results indicated that during daily activities, particularly posture transitions such as walking, sitting down, and standing up, older adults frequently relied on nearby furniture as immediate support. Furniture located in primary activity areas, such as sofas, dining tables, and beds, was often used as a convenient support interface due to its accessibility and proximity within the living environment.

This phenomenon reflects the behavioral adaptation of older adults to their surrounding environment. In situations where formal assistive devices such as handrails are not available, furniture located along daily activity routes may naturally become alternative support points. As a result, furniture within residential spaces may unintentionally provide supportive functions during movement and posture transitions, even though such supportive roles are not typically considered in conventional furniture design.

Handrail-Like Characteristics of Furniture Support

Another important finding of this study is that the dimensions of frequently used furniture support interfaces are similar to the typical height range of handrails. The measurement results indicated that many of the furniture edges used by older adults as support interfaces were distributed within a height range of approximately 55–85 cm. This range partially overlaps with the commonly recommended handrail height in residential environments.

This dimensional overlap suggests that certain furniture elements may unintentionally provide support conditions similar to those of handrails during daily posture transitions. When older adults perform movements such as standing up, sitting down, or maintaining balance while walking, furniture edges located within this height range may offer a convenient surface for hand contact and force application.

However, unlike handrails, household furniture is generally not designed specifically to support body weight or assist with balance during movement. Therefore, although furniture may exhibit handrail-like characteristics under certain conditions, its structural stability, surface properties, and edge design may not fully meet the safety requirements typically associated with dedicated assistive devices.

Design Risks of Furniture-Based Support

The findings of the expert evaluation further indicate that the safety of furniture-based support behaviors is influenced by several furniture design conditions. Experts pointed out that when household furniture is used as a support interface, potential risks may arise from factors such as support interface characteristics, furniture dimensions, structural stability, surface friction, and edge safety.

Unlike assistive devices that are specifically designed to support body weight and maintain balance, most household furniture is primarily designed for functional purposes such as seating, storage, or surface use. As a result, when furniture is unintentionally used as a support point during posture transitions, its structural properties and design features may not adequately accommodate the forces applied by the user.

These conditions may increase the potential risk of instability, slipping, or loss of balance during movement. Therefore, when considering furniture as a potential support interface in residential environments for older adults, design-related factors such as stability, surface texture, edge configuration, and dimensional suitability should be carefully evaluated.

Implications for Age-Friendly Furniture Design

The findings of this study indicate that older adults frequently rely on nearby household furniture as a source of physical support during daily activities. Therefore, in furniture design, in addition to considering the original functional purposes of furniture, it is also important to recognize the possibility that furniture may be used as support in actual use situations.

In particular, furniture elements located along daily activity routes, such as sofa edges and table edges, are often used as support interfaces during posture transitions. Incorporating supportive considerations into furniture design, such as appropriate height ranges, structural stability, safe edge configurations, and suitable surface friction, may help improve the safety and usability of residential environments for older adults.

Conclusion

This study explored how older adults rely on household furniture as support during daily activities in residential environments. Through behavioral observations and furniture measurements, the study identified common situations in which furniture was used as a support interface during posture transitions such as walking, sitting down, and standing up. The results indicated that furniture located near primary activity areas, particularly sofas and dining tables, was frequently used as a source of physical support.

The findings also revealed that the height of commonly used furniture support interfaces generally fell within a range of approximately 55–85 cm, which partially overlaps with the typical height range of handrails. This dimensional similarity suggests that certain furniture elements may unintentionally provide conditions suitable for hand support during daily movements.

However, expert evaluations indicated that the safety of furniture-based support behaviors may be influenced by several design-related factors, including support interface characteristics, furniture dimensions, structural stability, surface friction, and edge safety.

Since most household furniture is not originally designed to support body weight or assist with balance, these conditions may introduce potential safety risks when furniture is used as a support interface.

Based on the observational results and expert feedback, the potential risks associated with furniture-based support behaviors were further summarized according to behavioral scenarios and furniture types, as presented in Table 9. Corresponding design considerations are further discussed in Table 10.

Table 9
Potential Risks of Furniture-Based Support Behaviors by Scenario

Furniture	Behavior Scenario	Potential Risks
Chair	Sit-to-Stand	• Low seat height may increase sitting impact and make standing more difficult. • Lightweight furniture may slide when force is applied, reducing support stability.
Sofa	Walking Support	• Low support height and lack of graspable interfaces may reduce support effectiveness and affect walking stability. • Discontinuous support interfaces may lead to unstable support during walking.
Sofa	Sit-to-Stand	• Soft cushions or low seat height may increase the difficulty of standing and reduce stability. • The absence of armrests may reduce force application efficiency.
Sofa	Lie-to-Sit	• Overly soft cushions may provide insufficient support. • Lack of support interfaces may increase the difficulty of posture transitions.
Coffee Table	Walking Support	• Low support height, lack of graspable interfaces, and smooth surfaces may cause hand slipping or body imbalance. • Unprotected edges may increase collision injuries.
Coffee Table	Stand-to-Sit	• Low support height or slippery surfaces may reduce balance control during sitting. • Unprotected edges may increase injury risk during collision.
Dining Table	Walking Support	• Table edges may lack graspable interfaces, making it difficult to securely hold the furniture for support. • Insufficient structural stability may increase collision or imbalance risks.
Dining Table	Sit-to-Stand	• Lack of graspable edges may reduce effective force application. • Since the furniture is not designed for support purposes, force efficiency may be limited.

Table 10
Furniture Design Considerations for Supporting Older Adults

Furniture	Design Considerations
Chair	• Seat height should facilitate standing movements and reduce sitting impact. • Furniture stability and sufficient weight should prevent sliding when force is applied.
Sofa	• Appropriate seat height and cushion firmness should support posture transitions. • Armrests should be provided on both sides to offer symmetrical support and assist force application during posture transitions.
Coffee Table	• Graspable support interfaces may improve force application efficiency and body stability. • Anti-slip surfaces and rounded or protected edges may reduce slipping and collision injuries.
Dining Table	• Graspable support interfaces may facilitate temporary support. • Structural stability should prevent furniture movement when force is applied.

These design considerations highlight the importance of recognizing furniture as a potential support interface in residential environments. By incorporating such considerations into furniture and interior design, residential spaces may better support the safety and mobility of older adults and contribute to safer aging in place.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares that ChatGPT (OpenAI), a generative AI tool, and translation software were used in proofreading, refining the language, and assisting with academic writing expression and reference formatting in accordance with APA style guidelines. The usage was limited to language translation, correcting grammatical and spelling errors, improving clarity and accuracy of statements, and organizing references.

The author further declares that these tools were not used to generate original research content. The ideas, design, procedures, findings, analyses, and discussion are originally written and derived from careful and systematic conduct of the research.

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