

Original Paper

Design and Research on Human-machine Comfort of Baby Carriage for the Elderly with Grandchildren

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Abstract

With the development of aging society, more and more elderly people choose to take care of their grandchildren after retirement. Therefore, how to make these people take better care of their grandchildren, especially when using baby carriages, has become an urgent problem to be solved. This study focuses on the ergonomic design of comfort for the elderly with grandchildren when using strollers, and explores and understands the physiological and psychological needs of the elderly when using strollers. Through in-depth interviews, questionnaires and field observations, a detailed needs analysis of the target user groups was conducted. At the same time, combined with the physiological characteristics of the elderly, the paper puts forward some design suggestions and evaluation indicators, and proves a more comfortable and humanized baby carriage design through practice.

Keywords

man-machine design, with grandchildren, bending operation, comfort

1. Introduction

For the elderly, the decline of human function, the decline of mobility and multiple physical conditions, such as arthritis, heart disease and other diseases, make them face more challenges in the process of operating and using products. Moreover, elderly people with grandchildren often need to take care of their grandchildren (Kim, Lee, & Chung, 2020). They may need to squat and bend frequently, which may increase the pressure on the body, especially on the spine and joints. Therefore, they are in great need of help to relieve their physical stress. Products that improve the convenience of life. In this specific context, the significance of ergonomic design and product evaluation is particularly important. First of all, through ergonomic design, we can better understand the physical needs and capacity

constraints of the elderly, so as to design products more in line with them, such as improving the convenience and comfort of the elderly in caring for grandchildren, and enhancing their autonomy and quality of life (Kirkendall, 2019). At the same time, it also helps us to prevent and reduce various health problems caused by the use of uncomfortable products, such as muscle fatigue, visual strain, and even falls. Secondly, product evaluation can provide a scientific feedback mechanism to ensure that the product design is effective and can achieve the desired results. Through user testing and health impact assessment, we can find and correct product design problems in time, and further optimize products to meet the needs of the elderly (Gupta & Alhyari, 2022). In general, the ergonomic design and product evaluation for seniors with grandchildren is to make the product reduce the physiological stress on them and improve their quality of life while helping them to live daily and take care of their grandchildren. This has a profound impact on the physical and mental health of the elderly, both in the short term and in the long term (Zimmer, Natividad, Ofstedal, & Lin, 2002). At the same time, it also promotes more designers and manufacturers to pay attention to the actual needs and physiological characteristics of users, so as to produce more humane products.

2. Current Status of Strollers

A stroller, also known as a baby stroller or baby stroller, is a vehicle designed specifically for infants and toddlers to carry and push a child. The emergence and development of baby carriages are closely related to human civilization and industrial revolution. A device called a “stroller” was used to carry babies as early as the 8th century BC in ancient Greece and Rome. These early strollers usually consisted of two wheels and a wooden frame. Europe in the 17th century, Baby strollers began to gain popularity. At that time, strollers were mainly made of wood, shaped like a cradle, with four wheels on them, and pushed by an adult. In the 19th century, strollers were further developed. British inventor William Mason invented a stroller called “Baby Car”, which has a foldable design for easy carrying and storage. At the beginning of the 20th century, the design of strollers was improved even more. Owen Allison, an American designer, invented a device called “baby trailer”, which can be fixed on the back seat of a bicycle to make it easier for parents to carry their children while riding. In the middle of the 20th century, the design and function of strollers were improved and expanded even more. There are many different types of strollers, such as high-view strollers, lightweight strollers, baby tricycles, and so on.

Modern strollers come in a wide variety of styles and features for consumers to choose from (Sumter, Bakker, & Balkenende, 2018). The stroller has become one of the necessary tools for parents to take care of their children. With the advancement of science and technology, the design and function of strollers are constantly improving. Nowadays, strollers are not only light and easy to fold, but also have many additional functions, such as awning, safety seat, shopping basket and so on. The stroller market

continues to grow. According to statistics, the global baby carriage market has exceeded 10 billion US dollars, and is still growing at a certain rate every year (WU, 2011). With the improvement of environmental awareness, green and environmentally friendly baby carriages are becoming more and more popular with consumers. These strollers are usually made of recycled materials or use renewable energy such as solar energy. The intelligent trend of baby carriages is also gradually emerging. Some baby carriage manufacturers have begun to produce baby carriages with smart functions, such as connecting mobile apps, monitoring baby weight and sleep quality.

The development of baby carriage reflects the importance of human care and care for infants and young children, and also reflects the progress of human science and technology and civilization. With the continuous development of science and technology and people's attention to infant health and environmental protection (Hess, 2001), the future development trend of baby carriage will pay more attention to humanization, intellectualization and environmental protection.

3. Design Considerations for the Comfort of Existing Strollers

The comfort of the stroller is a very important aspect of the design process, because a comfortable stroller ensures that the baby feels comfortable and safe during the ride. The following are some considerations for comfort design of existing strollers: 1) Seat material: The seat of the stroller needs to be made of comfortable, breathable and easy-to-clean materials. Generally speaking, the seat material of the baby carriage is divided into cloth and leather. Fabric seats are soft to the touch and breathable for summer use, while leather seats are more durable. However, it has poor air permeability and is suitable for winter use. 2) Seat size: The size of the seat is crucial to the comfort of the baby. Designers need to ensure that the width, depth and height of the seat are suitable for the growth and development needs of the baby (Molenbroek, Albin, & Vink, 2017), providing enough space for the baby to stretch freely. 3) Seat angle adjustment: The seat angle of the stroller needs to be adjustable to meet the needs of the baby in different scenarios. Generally speaking, the seat can be adjusted to lie flat, recline and sit at three angles. The flat angle is suitable for sleeping, the reclining angle is suitable for resting and viewing the scenery, and the sitting angle is suitable for activities and learning. 4) Seat support: The seat of the stroller needs to have good support to prevent the baby from rolling over or slipping off during the ride. Designers can adopt a five-point safety belt to secure the baby in the seat and ensure the safety of the baby. 5) Handrails and pedals: The design of handrails and pedals also needs to take into account the comfort of infants. The armrest needs to be soft and easy to wash to prevent the baby from getting hurt when gripping the armrest during the ride. There should be enough space for the pedal.

4. Method of Research

The factors that need to be considered include the users of the stroller, that is, the physical characteristics and habits of the elderly with grandchildren, as well as the use environment of the stroller, such as road conditions, weather conditions and so on. In this research process, the following research methods can be used:

- 1) Questionnaire method: collect the feelings and suggestions of the elderly with grandchildren on the use of baby carriages by issuing questionnaires. The content of the questionnaire can include the evaluation of the convenience, comfort and safety of the baby carriage.
- 2) Analysis method: analyze the baby carriage products on the current market, understand their characteristics, advantages and disadvantages, as well as the market demand and trend of baby carriages for the elderly with grandchildren.

Comprehensive use of the above research methods can deeply understand the needs and problems of the elderly with grandchildren in the process of using the baby carriage, and provide a scientific basis for designing a more humane and comfortable baby carriage.

5. Selection of Target Groups

In the man-machine comfort design of the stroller for the elderly with grandchildren, the choice of the target group is very important. In order to make the baby carriage designed more suitable for the use needs of the elderly with grandchildren, the choice of target groups should be considered from the following aspects: 1) Age level: The elderly with grandchildren are generally older, and their physical condition and flexibility may decline. Therefore, when choosing the target group, we can consider choosing the elderly between 60 and 75 years old. The elderly in this age group are still relatively young. They are in good health and have more time and energy to take care of their grandchildren. 2) Physical condition: Choose the elderly with better physical condition as the target group to better understand the use needs and comfort of baby carriages. For example, you can choose the elderly without obvious joint pain, muscle fatigue and other problems. 3) Experience: When selecting the target group, priority can be given to the elderly who have experience in taking care of infants. They have rich practical experience and can more accurately reflect the problems existing in the use of baby carriages. Provide valuable suggestions for design. 4) Cultural background: Considering the family structure and cultural tradition in China, the elderly with grandchildren are usually the elders in the family and have certain authority and decision-making status. Choosing such a target group can ensure that the design of baby carriages is more in line with the actual needs of Chinese families. 5) Geographical location: The elderly with grandchildren in different geographical areas can be considered as the target group, so as to understand the impact of climate, terrain and other environmental factors in different areas on the use of baby carriages, so as to make the design more

effective.

6. Questionnaire Design

In order to design the man-machine comfort of the stroller for the elderly with grandchildren, we need to conduct a questionnaire survey and in-depth interviews with the target group. These two methods can effectively collect the opinions and suggestions of the elderly with grandchildren on the use needs, comfort and safety of baby carriages. The following is the specific design method: 1) Questionnaire design: According to the purpose of the study, determine the content of the survey, including the convenience of operation, comfort, safety, durability and other aspects of the stroller. Questions can be divided into multiple choice questions, fill-in-the-blank questions and open-ended questions to understand the needs of different aspects. 2) Distribution of questionnaires: The questionnaires can be distributed to the elderly with grandchildren through the community, relatives and friends and other channels. At the same time, some small gifts can be provided to increase the enthusiasm of participating in the questionnaire survey. 3) Data analysis: The collected questionnaires are analyzed to extract key information and provide the basis for the design.

7. Findings of Questionnaire Method

7.1 Physiological Difficulties and Needs of the Elderly in Using Strollers

Older people may face the following difficulties and needs when using strollers: 1) Decreased physical flexibility: With the growth of age, the physical flexibility of the elderly will gradually decline, and it may be difficult to bend, squat and other movements. Therefore, they need a stroller that is well designed and easy to operate to take care of the baby. 2) Vision loss: The vision loss of the elderly may affect their safety in using strollers. Therefore, strollers need to have clear identification and adequate safety equipment. In order to ensure the safety of the elderly. 3) Hearing and memory loss: The hearing and memory loss of the elderly may cause them to forget certain safety steps when using the stroller. Therefore, the stroller needs to be designed in a mode that can remind them of safety. 4) Energy-saving design: The elderly may have limited physical strength and need a stroller that can save physical strength. For example, you can choose a light and convenient stroller to reduce the physical exertion of the elderly. 5) Comfort: The elderly may have problems such as joint pain, which requires a good comfort design for the stroller, such as the padding of the seat and the angle of the backrest. 6) Safety: The elderly need to ensure the safety of the stroller when using the stroller. This includes wheel stability, braking systems, seat belts etc. 7) Adjustability: The adjustability of the stroller is also important for the elderly, such as the height and angle of the seat, which can be adjusted according to the height and comfort of the elderly. 8) Easy to operate: The elderly may need a stroller that is easy to operate, such as one-button folding, easy to push etc. 9) Accessories and after-sales service: The

accessories and after-sales service of the stroller are also very important. The elderly need a stroller that is easy to buy accessories and get after-sales service. 10) Reasonable price: The purchasing power of the elderly may be limited, and they need a stroller with reasonable price and high cost performance. To sum up, the use of strollers by the elderly needs to take into account the factors of physical flexibility, vision, hearing, memory and so on. The design of strollers should be more humane to meet the needs of the elderly.

7.2 Psychological Difficulties and Needs of the Elderly in Using Strollers

The psychological difficulties and needs of the elderly in using baby carriages mainly include the following points: 1) Psychological stress: Taking care of a baby is a heavy and responsible task, and the elderly may feel psychological stress. Therefore, the design and function of the stroller should be simplified as much as possible to make it easy and pleasant to take care of the baby. 2) Social needs: Older people may have less interaction with others because of the use of strollers. Therefore, the stroller can be designed with some social functions, such as a foldable sunshade. It enables the elderly to communicate with others when they take their babies outdoors. 3) Sense of accomplishment: Older people may feel lost and helpless because of their age and physical condition. Caring for babies can make them feel accomplished and needed. Therefore, the design and function of the stroller should make it easy for the elderly to take care of their babies, thus enhancing their sense of achievement. 4) Sense of security: The elderly may feel unsafe when using strollers because of their physical condition, hearing and vision decline. Therefore, the baby carriage should be designed with enough safety equipment, such as brake system, seat belt, etc., to give the elderly a sense of security. 5) Independence: Older people may need to rely on others because of their physical condition. Using a stroller allows them to maintain some independence. Therefore, the design and function of the stroller should allow the elderly to operate easily, thus maintaining their independence. 6) Psychological comfort: The design and color of the stroller may affect the psychological comfort of the elderly. Therefore, the design of the baby carriage should meet the aesthetic and psychological needs of the elderly, so that they feel comfortable and happy in the use process. 7) Adaptability: The physical condition and habits of the elderly may be different from those of young people. The design and function of the stroller should be able to adapt to the needs of the elderly, so that they can easily adapt and use. To sum up, the use of strollers by the elderly needs to take into account factors such as psychological pressure, social needs, sense of achievement, sense of security, independence, psychological comfort and adaptability, and the design of strollers should be more humane to meet the psychological needs of the elderly.

7.3 Considerations of Interaction with Infants

The interaction between the elderly and the baby when using the stroller is very important, which can promote the growth and development of the baby, and also enhance the affection and care between the elderly and the baby. When designing a stroller, the following points need to be considered: 1) Eye

communication: The stroller should be designed to allow eye communication between the elderly and the infant. For example, the height and angle of the seat of the baby carriage can be adjusted so that the baby and the elderly are at the same level, which is convenient for communication. 2) Interactive equipment: Some interactive devices, such as music players and swingers, can be designed on the stroller to add fun to the interaction between the elderly and infants. These devices should be easy to operate so that the elderly can easily use them. 3) Safety performance: The safety performance of the stroller is very important for the interaction between the elderly and the baby. Devices such as the stroller's brake system and seat belt should be designed to be easy to operate to ensure safety during interaction. 4) Convenience: The design and function of the stroller should facilitate the interaction between the elderly and the baby. For example, an armrest can be designed to facilitate the elderly to pick up and put down the baby, or a folding awning can be designed to facilitate the elderly to communicate with the baby. 5) Baby observation window: a large observation window can be designed for the baby carriage, so that the elderly can observe the state of the baby at any time, and increase the interaction between the elderly and the baby. 6) Adjustability: The seat, backrest and awning of the stroller should be adjustable to meet the needs of infants and the elderly. 7) Comfort: The seat, backrest and other parts of the stroller should be made of comfortable materials to ensure that the baby and the elderly feel comfortable during the interaction. 8) Portability: The baby carriage should be light and easy to fold, which is convenient for the elderly to carry and use in outdoor activities. To sum up, when designing the baby carriage, we need to fully consider the interaction needs between the elderly and the baby, and provide various interactive devices and functions to make the elderly and the baby feel happy and comfortable in the process of interaction.

8. Baby Carriage Design Recommendations for the Elderly with Grandchildren

8.1 Adjustable Handle Height

Designed for strollers with grandchildren, the adjustable handle height is a very useful feature. Here are some suggestions: 1) Design principle: The handle height of the stroller should be adjustable according to the height and comfort of the user to meet the needs of different elderly people. The design should ensure that the adjustment process is simple and easy to operate, so as to avoid the effort of the elderly. 2) Adjustment range: The adjustable handle height should have enough adjustment range to adapt to the elderly of different heights. For example, multiple adjustment gears can be set to ensure that different users can find their own height. 3) Comfort: The design of the handle should pay attention to comfort and select high-quality materials to avoid hand fatigue. In addition, a certain cushion can be arranged around the handle to improve the holding comfort. 4) Stability: When adjusting the height of the handle, the overall stability of the stroller should be guaranteed. A locking device can be used to ensure that the handle remains stable after adjustment to avoid accidental lowering or raising during use. 5) Easy to

operate: When designing the adjustable handle height, the convenience of the elderly should be taken into account. For example, a one-button operation can be set, and the height of the handle can be adjusted by simply pulling the button. 6) Strong and durable: The handle of the stroller should have sufficient strength and durability to ensure that there will be no problems such as loosening and breaking during long-term use. 7) Adaptability: The adjustable handle height design should be adaptable so that in future use, even if more family members use the stroller, it can meet their needs.

8.2 Simplified Switching Mechanism

For the baby carriage with grandchildren, the simplified switch mechanism can improve the convenience of the baby carriage and reduce the difficulty of the operation of the elderly. Here are some suggestions: 1) One-button operation: The switch mechanism of the stroller should be simplified as far as possible, such as one-button operation, which can fold or unfold the stroller by pressing the button lightly. This design can reduce the difficulty of operation for the elderly and make it easier for them to use. 2) No need to bend down: The design of the simplified switch mechanism should take into account the physical condition of the elderly. Avoid the need for them to bend down or exert themselves to complete the operation. For example, the switch can be designed at the handle of the stroller, so that the elderly can easily operate it with their fingers. 3) Easy to identify: The switch identification of the baby carriage should be clear and easy to understand, which is convenient for the elderly to identify and operate quickly. For example, Chinese characters or an icon can be used as a logo to improve the operation convenience of the elderly. 4) Stable and reliable: while simplifying the switch mechanism, ensure the stability of the stroller. A locking device can be used to ensure that the stroller remains stable during operation, avoiding accidental folding or unfolding. 5) Consider safety: When designing the switch mechanism of the stroller, safety should be fully considered. For example, safety protection measures can be set up to prevent the baby from operating the stroller by mistake and avoid potential dangers. 6) Material selection: In the switch part of the baby carriage, durable and wear-resistant materials can be selected to ensure the service life of the baby carriage.

8.3 Safety Considerations and Prompting System

It is very important to design a safety consideration and prompt system for the baby carriage with grandchildren. Here are some suggestions: 1) Stability and carrying capacity: The stroller shall be structurally designed with sufficient stability and carrying capacity to ensure that it will not be overturned or damaged during use by the elderly. At the same time, high-quality parts and materials should be used to ensure the service life of the stroller. 2) Safety belt design: The safety belt design of the stroller shall comply with the relevant safety standards. To ensure that the infant can be effectively protected in an emergency. In addition, the safety belt should be easy to operate, so that the elderly can quickly buckle and unbuckle the baby. 3) Braking system: The stroller should be equipped with a reliable braking system to ensure that the speed and direction of the stroller can be effectively

controlled during the operation of the elderly. At the same time, the braking system should be easy to operate to avoid accidents caused by the inconvenience of the elderly. 4) Speed limit design: The maximum speed limit can be set for the baby carriage to prevent accidents caused by the elderly pushing too fast. The design of speed limit should be easy to adjust, which is convenient for the elderly to adjust according to the actual situation. 5) Folding and locking design: The folding design of the stroller should have a locking function to ensure that there is no accidental folding or unfolding when folding or unfolding the stroller. At the same time, the folding locking design should be eye-catching to remind the elderly to pay attention. 6) Anti-collision design: The wheels of the stroller should have anti-collision function to reduce the accidental collision that may occur during the operation of the elderly. 7) Prompt system: The baby carriage can be designed with a prompt system, such as built-in voice prompt or light prompt, to remind the elderly to pay attention to the state changes of the baby carriage, such as folding, unfolding etc. In addition, the prompting system can also remind the elderly to pay attention to the surrounding environment during the operation of the baby carriage, so as to improve the safety of use. 8) Easy maintenance: The design of the stroller should take into account the maintenance ability of the elderly, minimize the parts that need to be repaired, and provide clear maintenance guidelines.

8.4 Experience the Improvement of Comfort

For the baby carriage with grandchildren, it is very important to improve the comfort of experience. Here are some suggestions: 1) Seat comfort: The seat of the stroller should be made of soft and breathable materials with good support to ensure the comfort of the baby during the ride. In addition, the seat should be equipped with safety protection devices, such as five-point safety belts, to ensure the safety of infants. 2) Shock absorption performance: The shock absorption performance of the stroller is very important to reduce the bumpy feeling of the baby during driving. High-quality shock absorbers, such as pneumatic shock absorbers or spring shock absorbers, can be used to improve the driving stability of the stroller and increase the ride comfort. 3) Comfortable handle: The handle of the stroller should be made of soft and non-slip material to provide a good grip and reduce the fatigue of the elderly during operation. In addition, adjustable handle height can be set to meet the needs of elderly people of different heights. 4) Portable: The weight and size of the stroller should be moderate to facilitate the implementation of the elderly. Lightweight materials, such as aluminum alloy, can be used to reduce the overall weight of the stroller and improve the convenience of the stroller. At the same time, the wheels of the baby carriage should be smooth enough to reduce the resistance of the elderly. 5) Awning design: The awning of the stroller should have enough shading area to effectively block the sun and protect the baby from ultraviolet rays. At the same time, the material of the awning should have good air permeability to keep the air circulating in the stroller. 6) Storage space: The stroller should be equipped with sufficient storage space to facilitate the elderly to carry the supplies needed by the baby.

Storage spaces should be designed to be easy to access and store for ease of use. 7) Removable design: Some components of the stroller should be removable for easy cleaning and replacement. For example, seats, awnings and other components can be easily cleaned and replaced to ensure the hygiene and service life of the stroller. 8) Appearance design: The appearance design of the baby carriage should be aesthetic to meet the aesthetic needs of the elderly. At the same time, bright colors can be used to improve the recognition of baby carriages and increase safety.

9. Conclusion

The man-machine comfort design of the baby carriage for the elderly with grandchildren aims to improve the use experience of the baby carriage and reduce the fatigue of the elderly. According to the relevant research and experimental verification, we can draw the following conclusions:

- 1) Seat design: Comfortable seat design can improve the use experience of the stroller. The seat shall be made of soft and breathable material with good support. The angle adjustment function of the seat should meet the needs of different scenarios, such as lying, semi-lying and sitting.
- 2) Handle design: Comfortable handle design helps to reduce the fatigue of the elderly during operation. The handle should be made of soft and non-slip material, and the height can be adjusted to meet the needs of the elderly of different heights.
- 3) Body design: The body of the stroller should have good stability to ensure that it can be easily pushed during driving. At the same time, lightweight materials and appropriate size are used to improve the portability of implementation.
- 4) Storage space design: Sufficient storage space can facilitate the elderly to carry the supplies needed by the baby. Storage spaces should be designed to be easy to access and store for ease of use.
- 5) Awning design: The awning should have sufficient shading area and good air permeability to protect the baby from ultraviolet rays, while maintaining air circulation in the stroller.

In a word, in order to improve the use experience of the stroller and reduce the fatigue of the elderly, the man-machine comfort design of the stroller for the elderly with grandchildren should be considered comprehensively from the aspects of seat design, handle design, body design, storage space design and awning design. At the same time, we should strengthen the management and guidance of product development, production, use and maintenance to ensure the safety and comfort of baby carriages.

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