



Designing for Children

- With focus on 'Play + Learn'

Factors in Ergonomic Design of 6-to-18-month Baby Carriers for Elderly People

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Abstract: The lifestyle of today's spouses in Thailand and ASEAN countries is a working mother or father. Hence, the child-rearing duties are passed along to the elderly people within the family. Since these elderlies need to carry the baby along with them in a baby carrier in some occasions, the load and ergonomic of the carrier need to be designed appropriately. The learning ability of a child at the age of 6-18 months is the highest in its life. One of the objectives of this study was to investigate baby carrier design that let the child face out to the world to give it the chance to learn about the world quickly at the time that it can learn the fastest. The full objectives of this study were to investigate the factors in ergonomic design of a baby carrier and to develop a design guideline for 6-to-18-month baby carriers that would be ergonomic for elderly people. The research procedures were as follows: (1) reviewing the literature about four types of 6-to-18-month baby carriers—front carry (facing-in), front carry (facing-out), back carry, and hip carry; (2) comparing and analyzing all current baby carrier designs; and (3) synthesizing factors affecting such baby carrier design related to posture and load-bearing point in ergonomic design for elderlies. The obtained results reveal that the four main factors in ergonomic for elderly people were the following: (1) the posture of the elderlies as they are using the carrier, (2) the load-bearing point of the baby carrier, (3) the load-bearing points on the body of the elderlies, and (4) the carrying types of the baby carriers. This paper also presents a guideline for intelligently designing 6-to-18-month baby carriers for consumers in Thailand and ASEAN countries that are ergonomic for elderly people.

Key words: *Design guideline, Baby carriers, 6-to-18-month baby, Ergonomic for elderly people.*

1. Introduction

Living in Thailand has been drastically changed by modern advances in science, technology, and innovation as well as social and economic changes. These changes has made tremendous impacts on families, the smallest unit of the society, in regard to their

structure, size, and lifestyle as well as the relationships among family members (Phothisita, 2009), especially in big families where grandparents and young children live together (Husserl, 1965). Boonkwang and Ayuwat (2017) stated that the movement of laborers from the country to work in big cities has resulted in isolation of the members of the older generation. Many workers have also put their children into the sole care of their grandparents. This trend is expected to be ever increasing in the rural areas.

Temporary childcare strongly affects the lifestyle of elderly people. Komjakkraphan and Chansawang (2015) found that currently, for many families, childcare has been relegated solely to elderly members of the families. Moreover, they may also have to earn some auxiliary income for the family and take care of affairs in their home. Jendreck (1993) stated that as elderly people take on the role of temporary parents; they are affected in four ways: (1) they become exhausted; (2) they lost their relation with their friends; (3) they may have less time to spend with their family members; and (4) misunderstanding may occur between elderly people and their mates.

A good relationship between parents and children, from infant to three years old, helps stimulate children's development. It helps promote development of their physical abilities such as maintaining a good balance, making precise movement, practicing recognition by the sense of touch, coordinating the eyes and the hands to do certain activities, and developing gross motor skills, as well as their mental abilities such as recognition, observation, and memorization of objects and their surroundings, analytical ability, and communication by physical actions (Thanatchang, 2007). Parents are instinctively attached to infants by nature, whereas elderly people taking the role of the parents are not by nature, but they also provide love and care for the children as surrogate parents.

In taking care of small children and doing some activities together, oftentimes, elderly people need to carry the child or support its weight. A baby carrier is divided into 5 types: (1) Stretchy wrap; (2) Ring sling; (3) Woven wrap; (4) Mei tai; and (5) Structured carrier, as shown in Fig. 1. The researcher was interested in investigating the structured carrier which should be suitable for babies at 6-to-18 months of age and older till they reach a weight of 18-20 kg. For elderly people, this kind of carrier has a wide and padded hip belt that can distribute the weight of the baby to the hip and not on their shoulders. Andersson (2019) stated that a child should sit in an ergonomic posture, a frog posture, for the parent. Its weight should be supported by the pelvis and thighs of the parent. The back of the parent also supports the baby weight. A parent can place a baby in a tummy-to-tummy position or back-to-tummy position. Some carriers also let the parent place a baby on his or her hip. Structured carriers are among the most comfortable carriers, especially if you intend to carry a child even as it gets bigger and heavier.



(1) Stretchy wrap (2) Ring sling (3) Woven wrap (4) Mei tai (5) Structured carrier

Figure 1. The 5-different-types of baby carrier.

The physiological posture of carrying a child can be of 4 types; (1) front carry (facing-in), (2) front carry (facing-out), (3) back carry, and (4) hip carry shown in Fig. 1. The baby carriers for these postures were of different designs. Since a 6-18-month-old baby should have opportunities to be stimulated by its parent and the environment, the design of the carrier should allow it those opportunities, i.e., the carrier should have a padded frame that can support the baby for a long time without tiring it; the carrier should let the baby face out toward the environment and away from the torso of the parent.

The structure of a baby carrier today has not been designed with the ergonomic of elderly people in mind because the shape of the carrier does not fit their body well. In addition, there is a relatively wide space between the carrier and the person carrying the baby, hence it is possible that the baby may wriggle out of the cradle of the carrier and fall down. This is especially dangerous for a small baby because it still cannot hold its posture rigidly enough, and when it has to put its weight on the seat of the carrier for a long time, it may wriggle or limp and fall. Today's carrier is also not so ergonomic for the elderly person carrying the baby because the weight of the baby is supported only by the torso of the elderly person. Moreover, for a really young baby, its neck cannot be held rigidly by itself, so the elderly person carrying the baby may have some difficulties at handling the neck of the baby so that it does not grate with a side band of the carrier, i.e., the baby may get injured and it is difficult for an elderly person carrying it to prevent that.

Therefore, good design factors for a 6-18-month-old baby carrier for an elderly person play an important role in preventing baby's neck grating injury and breathing difficulty. The weight distribution of the carrier on the body of the elderly person carrying the baby is also needed be designed according to the ergonomic of the elderly person and anyone who may carry the baby. Finally, good design factors should enable a baby to fully develop, both physically and mentally.

2. Material and methods

Four types of 6-to-18-month baby carriers for elderly people were gleaned from

literature review and considered in this study. The front-carry (facing-out) type was considered the best type because it allows the baby to observe and learn the world in front of it. Hence, the author focused on the design of this type of baby carriers.

(a) Baby carriers

Three front-carry baby carriers were purchased from a shop in Bangkok, Thailand. The three baby carriers: D1, D2, and D3 shown in Fig. 2, were of different designs. All three were imported from England and rather quite expensive compared to other baby carriers that the shop carried.



Figure 2. Infantino brand 6-to-8-month baby carrier.

(b) Simulation

The three carriers were computer-modeled into three-dimensional models with 3-DS Max software. The models were then inputted into ANSYS engineering simulation software. ANSYS determined the load of a baby's weight borne by any points of the three-dimensional model of each carrier. The main purpose was to find the point on each carrier that bears the maximum load and the maximum load that it could bear as factors in ergonomic design of baby carriers for elderly people. ANSYS is a force-simulation program used by many big corporations in various industries to simulate the designs of their products, corporations such as Toyota, Honda, and Hyundai.

(c) Procedure

(i) The first step of this work was to consider all available choices of 6-8 months-old baby carriers reported in the research literature and commercial market to find several suitable carriers to test. In the end, three facing-out carriers were chosen. They were the top three models, most popularly picked by Thai consumers according to a survey by a website called 'baby best buy in Thailand'. They were also the three top-selling items.

(ii) Next is the construction of 3D models of the carriers. The models were constructed by 3ds max software: D1, D2, and D3 in Fig. 3. The dimensions and geometry of the models were identical to the real carriers, and all physical differences were accurately incorporated into the models.

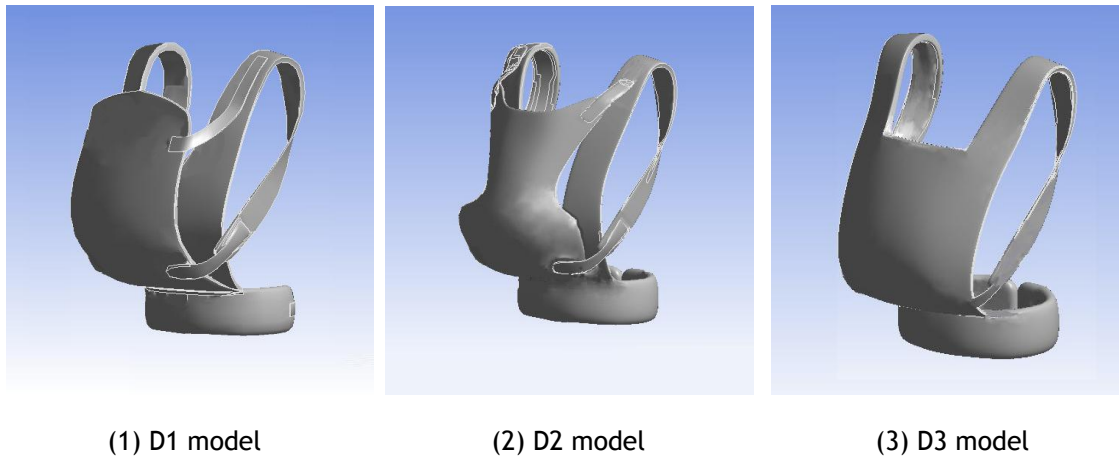


Figure 3. The dimensions and geometry of the D1, D2, and D3 models.

(iii) The three 3D models were imported into ANSYS force simulation software along with all necessary physical parameters of the material such as stiffness, flexibility, and durability against impact force in Fig. 4.

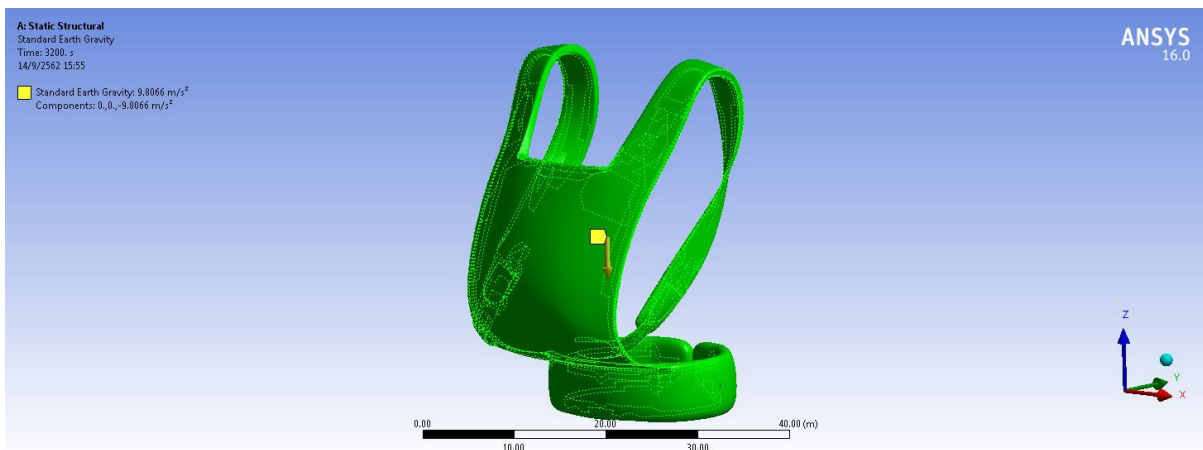


Figure 4. Input of stiffness, flexibility, and durability parameters of the D1, D2, and (D3) models into ANSYS simulation program.

(iii) The simulation software was run on a PC on Windows platform with an i5 CPU and 8 gigabytes of RAM. In this study, a different level of for loading-point that a 6-to-8-months baby carriers three models (D1, D2, and D3) of could withstand is represented by a different color—the lowest level is represented by red color and the highest is represented by blue as shown in the color scale in Fig. 5.

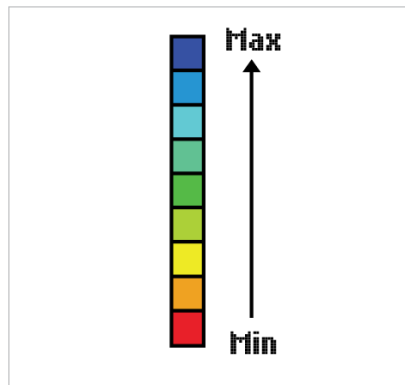


Figure 5. Color-scale of loading-point of an area in the simulation models.

(iv) The nature of the loading-points of all 6-to-18-month carriers baby from ANSYS force simulation results were compared and analyzed, and the components of the carrier associated with the best loading-point were included in factors in ergonomic design.

3. Conclusions

The lifestyle of people in the working age building a family in big cities greatly affected the relationships between family members as well as the physical and mental development of the children in the family. This is especially true for infants, 6-18 months of age. At this age, the development is most extensive and continuous until the end of childhood.

Currently, several countries have completely become an aged society. Thailand's 12th National Economic and Social Development Plan 2017-2021 (2017) states that the reasons of inadequate mental development in young children in Thailand were that the parents did not have a good education themselves and the parents lacked time to properly raise the children. Parents should properly develop their children's physical and mental capacities as well as knowledge and skills such that the children will grow up to be quality members of the society.

In Thailand and many countries in Southeast Asia, the burden of raising an infant into young children mainly rests on the grandparents or other elderly people (Foundation of Thai Gerontology Research and Development Institute (2016). However, the design of products that parents use often neglects the real users of the products in this context, elderly people. Current designs of products for enhancing children's mental capacity and creativity do not properly apply modern technologies and innovations to solve problems for the real users, children and elderly people. In the context of Thailand, there are still no analysis and synthesis of guidelines for ergonomic designs of products for their main and secondary users.

Our objectives were to determine (1) the posture of the elderlies as they are using the carrier, (2) the load-bearing point of the baby carrier, (3) the load-bearing points on

the body of the elderly, and (4) the carrying types of the baby carriers. We expected that the findings from this study would help considerably in the design of this type of baby carriers. However, the findings do not give us conclusive evidence for the positive or negative effects of the design of the current face-out-baby-carriers on their ergonomic for elderly people nor the elderly people's posture. The evidence for a positive effect of the baby carriers is not definite, only suggestive, and the lack of reproducibility of the results prevents firm conclusions from being drawn. Similarly, the results of the three simulation studies investigating the factors in ergonomic design of 6-18-month baby carriers for elderly people were inconclusive. No design provided decisively better ergonomic factors than the other two. Nonetheless, the investigation into the ergonomic of load-bearing point for elderly people provided an interesting basis for further study. The simulation can point out causal relationships between the types of baby carrier, ergonomic design principles, and elderly people's loading points at their chest, shoulder tip, back, knee, and ankle in their standing posture people. Future studies should investigate the ergonomic design of the cushion seat of baby carrier for elderly people such as the design of the back-cushion seat, waist belts, and shoulder straps for baby carriers.

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