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BASED ON PHYSIOLOGICAL CHANGES IN CHILDREN**

**The aim** of this study is to determine the design needs and methods of children's furniture for growth from the perspective of children's physiology. Due to the current advocacy of sustainable design concepts, new structures and accessories can also meet the requirements of children's furniture design. At this stage, research on the design of growthable children's furniture is very important and timely.

**Methodology.** The study used the analysis of literature sources on the design of furniture, Comparative research method. Case analysis method, structural-functional analysis, synthesis of research results, etc. are used.

**Results.** Analyzing the design elements of growable furniture from the perspective of children's physiology, the types of furniture that can grow children are divided into three categories: children's desks and chairs, children's beds, and children's storage furniture. According to the requirements of children's human-machine ratio, it is determined that the height of children's desks and chairs can be adjusted, and the angle between the desktop and the back of the children's chair can also be adjusted. From an ergonomic point of view, these requirements are determined based on the child's height, weight and developmental characteristics. It is determined that through the standardized design, the children's bed can be disassembled or installed, the height of the bed can be changed, and the combination of the bed and other functions can also be satisfied. Determine the category of children's storage type furniture storage items, classify according to different items, and put forward requirements for the storage of different types of items.

**Scientific novelty.** We explore the impact of children's physiological changes on children's furniture, meet the requirements of children of different ages for the use of furniture, at the same time, provide specific design ideas.

**The practical significance** of the obtained results lies in the possibility of their application for designers and manufacturers in the design of children furniture.

**Keywords:** design; children; physiology; ergonomics; furniture design; children's furniture; storage furniture.

**Introduction.** Growthable children's furniture refers to children's furniture that can meet children's physical and psychological characteristics in different periods and grow up with children. Children have different needs for furniture in each growth cycle. It is not practical for most families to replace furniture in each period. When parents choose children's furniture, they must pay attention to the "growth" of the product. Therefore, grasping the characteristics of children's physiological changes in different periods becomes the key to designing furniture for growing children.

**Analysis of previous researches.** Author Kyung Kim Ja correctly identified considerations for the design of children's storage furniture by age group, and conducted a holistic

examination of domestic and foreign children's storage furniture products. Furniture that is easy for children to take out objects by themselves, and enables recognition and emotional development by taking into account the development of each age group. Basic data and types of storage furniture are presented for the development of children's storage furniture suitable for each age group. By comparing the product types at home and abroad, the items that need to be supplemented and improved in the future development of storage furniture for different age groups are introduced [1].

Authors Moon Sun-Wook et al studied the factors that accurately identify the design of children's rest furniture by age group, conducted a comprehensive inspection of

domestic and foreign children's rest furniture products, and classified and analyzed design types, colors, and designs according to age groups. Provide basic data for the development of rest furniture for children of all ages, and recommend appropriate types of rest furniture for each age group [2].

Authors J. Ye, W. Li, C. Yang studied the application of scene theory to the design of modular children's furniture, which can effectively help designers grasp the relationship between products and users and their needs, thereby further improving product rationality and product satisfaction, and also it provides a new effective exploration for the design of modular children's furniture [3]. Q. Wu and others studied the sustainable design of children's beds, combined with the theory of modular design, to solve the problem of the life cycle of children's beds, and better meet the needs of children [4]. The author X. Xiong et al. used group technology to conduct standardized experimental research on children's solid wood furniture parts [5].

Authors J. Wang and others combined AHP and TOPSIS methods to study the evaluation indicators of parent-child interactive game furniture design, which is convenient for designers to quantitatively analyze the design advantages and disadvantages of related products, and is of positive help to control and improve design quality [6].

The author L. Jiang et al. studied the influence of adolescents' color preference and color choice on the color design of children's furniture, but the degree varies with the furniture category, and also includes the influence of gender and age [7].

Author T. Minli Wan studied the impact of perceived product quality and positioning on healthy and sustainable lifestyles (LOHAS) on consumer price preferences, using data from a market survey of children's furniture in two Chinese metropolises (Shanghai and Shenzhen). Consumer price preference is negatively affected by "basic product attributes", but

positively affected by consumers' orientation towards Lohas, gender, and education level [8].

Author Kim Ja Kyung address the importance and necessity of playable furniture to promote the physical, social, emotional, language, and cognitive development of children aged 4 to 7 in preschool. Through comparative analysis of cases, find the concept and basic conditions of playable furniture, provide basic data for the development of playable furniture, and provide basic data, form, material and color for the development of ideal playable furniture [9].

The author, C. Salvador have a background in product design investigations with a focus on children's furniture (high chairs), researching issues of emotional sustainability to reduce waste and optimize products. A better understanding of children's sensitive and subjective attachment to objects, and the decisiveness of ergonomics in the research process of design projects [10].

Author Z. Y. Phuah et al. research aims to conceptualize creative and repurposed children's furniture. The invention can be used as an accessory for children's furniture such as cribs, high chairs, bedside rails, chairs, etc. While retaining the added value of many reuse functions, the invention prolongs the life of the furniture, reduces the consumer's expenditure cost, and saves space [11].

The studies of the above scholars are of great reference value. It is worth noting that in the previous studies, it was found that the field of children's furniture design from the perspective of physiological growth changes is blank and needs to be explored and studied.

**Statement of the problem.** Children's basic physiological performance, basic life content and characteristics in the living room directly determine the choice of children's furniture types. The furniture that provides children with learning, reading and playing is mainly table and chair furniture; the basic type of furniture that provides children with good rest is bed furniture; the furniture provided for children to store sundries, books, toys, etc. is

storage furniture. The article analyzes the specific requirements of children's physiological growth characteristics for these three types of furniture.

**Results of the research.** Childhood is a critical period for everyone's personality formation, perceptual training, and cognitive development, as well as an important period for children's physical growth and intellectual development. Parents and all walks of life are paying more and more attention to the environment in which children grow up. Children's growth environment has a subtle influence on children's development [12]; children's furniture is a necessary element of children's growth environment. If a set of furniture can accompany children from childhood to youth, it must be designed according to the characteristics of children's physical and mental development. Consider the needs of children at various stages of growth and development, and pay attention to the growth of furniture (Table 1; Table 2) [14].

**Design requirements for children's tables and chairs furniture:** Children lack self-protection awareness. Children's tables and

chairs can play a pivotal role in children's furniture. They are props for children to play and learn during their growth and development, design. Children use suitable children's desks and chairs, which can reduce fatigue, develop good reading and writing habits, have a good sitting posture, prevent myopia and maintain vision, prevent abnormal curvature of the spine, and enable children to grow up healthily.

Lively and active is the nature of children, so safety is very important. The structure needs to be stable to avoid the appearance of edges and corners, especially the armrests of chairs and sofas, which need to be smooth. Designers need to design children's tables and chairs according to the ratio of children to man-machine, and use ergonomic principles so that children can develop good reading and writing habits. Children's tables and chairs need to be adjusted according to their height and weight. In order to prevent abnormal curvature of children's spine, children's table board and children's chair back board need to adjust their angles according to children's bone growth and development characteristics.

**Table 1**

Height and weight chart of Chinese boys aged 0-18

Age	Height(cm)				Weight(kg)			
	short and small	slant short	standard	super tall	Thin	standard	overweight	obesity
1 year old	71.2	73.8	76.5	79.3	9	10.05	11.23	12.54
2 year old	81.6	85.1	88.5	11.24	11.24	12.54	14.01	15.37
3 year old	89.3	93	96.8	100.7	13.13	14.65	16.39	18.37
4 year old	96.3	100.2	104.1	108.2	14.88	16.64	18.67	21.01
5 year old	102.8	107	111.3	115.7	16.87	18.98	21.46	24.38
6 year old	108.6	113.1	117.7	122.4	18.71	21.26	24.46	28.03
7 year old	114	119	124	129.1	20.83	24.06	28.05	33.08
8 year old	119.3	124.6	130	135.5	23.23	27.33	32.57	39.41
9 year old	123.9	129.6	135.4	141.2	25.5	30.46	36.92	45.52
10 year old	127.9	134	140.2	146.4	27.93	33.74	41.31	51.38
11 year old	132.1	138.7	145.3	152.1	30.95	37.69	46.33	57.58
12 year old	137.2	144.6	151.9	159.4	34.67	42.49	52.31	64.68
13 year old	144	151.8	159.5	167.3	39.22	48.08	59.04	72.6
14 year old	151.5	158.7	165.9	173.1	44.08	53.37	64.84	79.07
15 year old	156.7	163.3	169.8	176.3	48	57.08	68.35	82.45
16 year old	159.1	165.4	171.6	177.8	50.62	59.35	70.2	83.85
17 year old	160.1	166.3	172.3	178.4	52.2	60.68	71.2	84.45
18 year old	160.5	166.6	172.7	178.7	53.08	61.4	71.73	84.72

Table 2

Height and weight chart of Chinese girls aged 0-18

Age	Height(cm)				Weight(kg)			
	short and small	slant short	standard	super tall	Thin	standard	overweight	obesity
1 year old	69.7	72.3	75	77.7	8.45	9.4	10.48	11.73
2 year old	80.5	83.8	87.2	90.7	10.7	11.92	13.31	14.92
3 year old	88.2	91.8	95.6	99.4	12.65	14.13	15.83	17.81
4 year old	95.4	99.2	103.1	107	14.44	16.17	18.19	20.54
5 year old	101.8	106	110.2	114.5	16.2	18.26	20.66	23.5
6 year old	107.6	112	116.6	121.2	17.94	20.37	23.27	26.74
7 year old	112.7	117.6	122.5	127.6	19.74	22.64	26.16	30.45
8 year old	117.9	123.1	128.5	133.9	21.75	25.25	29.56	34.94
9 year old	122.6	128.3	134.1	139.9	23.96	28.19	33.51	40.32
10 year old	127.6	133.8	140.1	146.4	26.6	31.76	38.41	47.15
11 year old	133.4	140	146.6	153.3	29.99	36.1	44.09	54.78
12 year old	139.5	145.9	152.4	158.8	34.04	40.77	49.54	61.22
13 year old	144.2	150.3	156.3	162.3	37.9	44.79	53.55	64.99
14 year old	147.2	152.9	158.6	164.3	41.18	47.83	56.61	66.77
15 year old	148.8	154.3	159.8	165.3	43.42	49.82	57.72	67.61
16 year old	149.2	154.7	160.1	165.5	44.56	50.81	58.45	67.93
17 year old	149.5	154.9	160.3	165.7	45.01	51.2	58.73	68.04
18 year old	149.8	155.2	160.6	165.9	45.26	51.41	58.88	68.1

Children's desks and chairs should match the size of the desk and chair. The author refers to the "Functional Dimensions of School Desks and Chairs" standard (GB/T 3976-2002), and according to the combination of "32 mm system" and ergonomics, the seat surface of children's seats The height should be adjustable from 190–440 mm, the chair back height can be adjusted from 700–1000 mm, and the chair depth can be adjusted from 270–440 mm. Keep the seat surface horizontal (Fig. 1, a), or tilt backward and downward within 2°. The backrest is tilted back within 6° from the vertical surface, and the chair back and chair form an angle of 95-110°, because the pressure on the fourth to fifth lumbar vertebrae of the body can be reduced when sitting, and you can lean on the back of the chair very easily, less prone to physical fatigue (Fig. 1, b).

The main design requirements for a growing children's table are:

- height adjustable, including desktop height adjustment 520-760mm (Fig. 2, a);
- the size and inclination of the desktop can be adjusted to meet different functional

requirements. Generally, the inclination angle range of the desktop is 0–50° (Fig. 2, b), which can meet different functions, so that the distance between the inclination of the desktop and the line of sight is uniform, and the vision is relieved. Fatigue, protect eyesight (Fig. 2, b, c).

**Children's beds design requirements:**

Research indicates strong connections between child ADHD, child ODD/CD, and sleep [13]. Parents are paying more and more attention to children's sleep quality, and letting children sleep in their own cribs is the first step. Moreover, the requirements for children's beds are very different from those for adults. If children are allowed to live in adult beds for convenience, it will adversely affect the growth and development of children. The physical development of children aged 3–15 is at its peak, especially in terms of height and weight, so there are special requirements for children's beds:

- children's beds needs to be adjustable in width and length in order to adapt to the child's physical growth. Bed legs need to be detachable or installable through a

standardized design to change the height of the bed;

- the design form of children's bed is based on the standard bed, with various changes, loft bed (Fig. 3, a), bunk bed (Fig. 3, b), bed with lockers (Fig. 3, c), beds with slides, sofa beds, etc., different forms can meet different functions, and can save space, storage, entertainment, etc.;

- children are lively and active by nature. Children often play and jump on the bed. The safety of children's bedding is extremely important and it needs to have good firmness

(Fig. 4, a). Strong connections need to be designed to ensure that no collapse occurs;

- every part of the crib that touches the child should be smooth and round to avoid protruding edges and corners that may cause harm to the child (Fig. 4, b);

- children's beds need to have a good sense of body and touch. The metal texture is too hard and cold, which is not suitable for children. The plastic texture is too thin and not strong enough. Therefore, wooden children's beds are the most ideal, it is both sturdy and durable, with good texture and touch.



**Fig. 1.** Adjustable child seat: a – child seat back and seat surface adjustment, China, 2023; b – dimensions of various parts of the child seat, China, 2023



**Fig. 2.** Growing children's table: a – children's Table Dimensions, China, 2023; b – desktop angle adjustment, China, 2023; c – desktop adjustment to meet different usage functions, China, 2023

At present, there is no national standard for children's beds. According to the growth and development characteristics of Chinese children, summarize the length of the children's bed as 1380 mm–2000 mm, the width is 600 mm–1200 mm, and the height is 400 mm. The height of the bed can be changed, the length of the bed leg module is 400 mm, and the height of the guardrail is 300 mm, which is a more reasonable size.

#### **Storage furniture design requirements.**

After the age of 3, children play and study more and more, as well as various toys and books. However, their active nature makes it impossible for them not to throw things away. Of course, these items cannot be piled up randomly. At this time, the storage work of the children's room is extremely important. Reasonable storage functions are not only convenient for parents to organize, but also can cultivate children's good living habits from an early age. The external dimensions of the locker mainly need to consider the physiological characteristics of children, and the height of the items placed should be convenient for children to get their things and put them back easily. Therefore, from the lockers used in the preschool age to the lockers used in the school-age period, the most important changes are the changes in the height of the lockers and the flexible combination of lockers (Fig. 5).

Lockers can be classified according to different functions. Wardrobe, storage of clothing, bedding and other items. This kind of locker needs to pay attention to the design of the internal size and division of the wardrobe so that children can use it. The basic functions of the wardrobe must be provided: there must be space for hanging long and short clothes (Fig. 6, a); space for storing stacked clothes (Fig. 6, b); the space for placing underwear, socks and other small items of clothing can also be designed as a drawer structure (Fig. 6, c); the space for placing bedding, boxes and other items. The most ideal state inside the children's wardrobe is that the height is

adjusted to the internal space according to the children's height changes during the period of non-use (Fig. 5).

Bookcases, cabinets for storing books, reference materials and other learning tools. There are various shapes and designs of bookcases, but it is best to use squares as the main design of the inner grid, so that children can arrange books and items neatly and develop good habits. Books, paper, pens, and other types of items that preschoolers need are not many, and as they grow older, more and more of these items, especially books of different kinds. Therefore, when designing and planning the storage function of the furniture in the children's room, it is necessary to reserve enough additional storage space to accommodate it. Therefore, the design of the bookcase can be considered in the size and form of the adult bookcase.

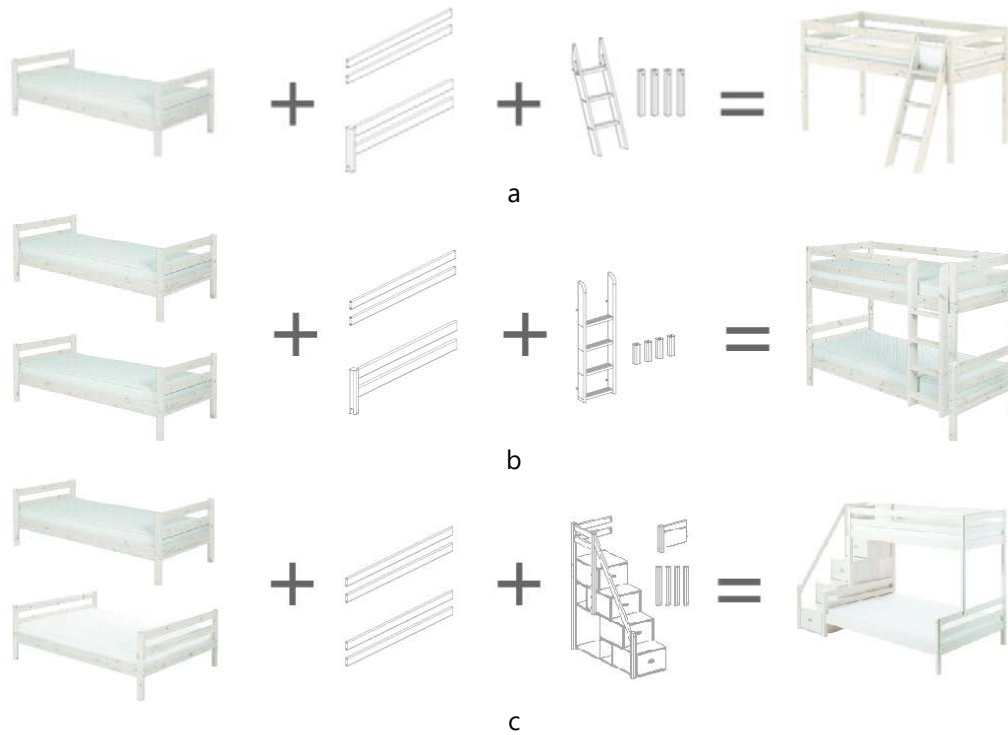
Item cabinet, because children are a special group, they have a wide variety of items, with different sizes and shapes, and there is no uniformity, such as toys, sporting goods and so on. Storage cabinets are further divided into:

- hidden storage, hiding things, such as hiding under the bed, or making the stairs of the loft bed into a storage cabinet, etc. (Fig. 3. c);

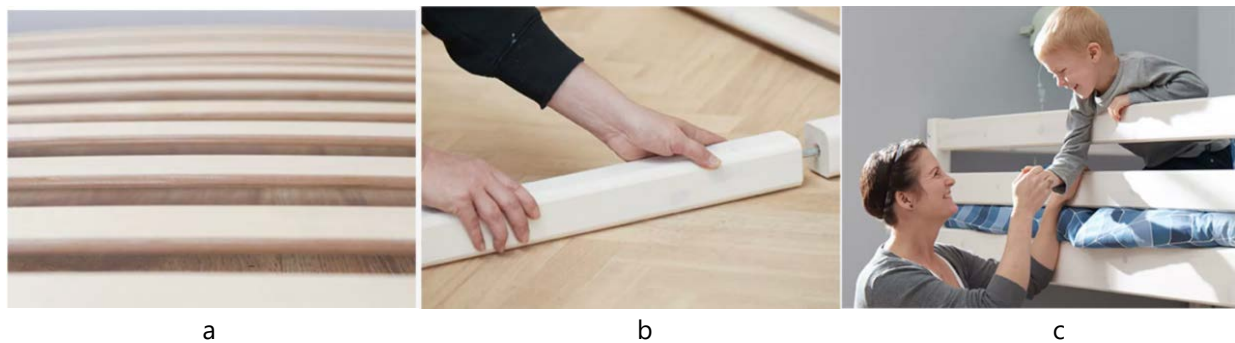
- open-shelf storage, using partitions with different space divisions to separate toys of different sizes, and the shelves can also be fixed on the wall to make toys and dolls become decorations, which can also save space (Fig. 7, a);

- mobile storage, storage space with casters, also available for children to play (Fig. 7, b).

The above are the types of storage cabinets suitable for children's growth. Cabinet furniture conforms to the characteristics of children's physiological growth, can help children develop a clean and orderly living habit, and is also convenient for parents to take care of children.



**Fig. 3.** Growing child bed: a – basic bed into elevated bed, Denmark, 2023; b – basic bed changes into double bed, Denmark, 2023; c – basic bed change stair storage bed, Denmark, 2023



**Fig. 4.** Safety characteristics of growth child beds: a – good load-bearing effect, Denmark, 2023; b – round and round components, Denmark, 2023; c – guardrail protection, Denmark, 2023



**Fig. 5.** Changes in cabinet combinations for growing children, China, 2023





**Fig. 6.** Internal layout of growth oriented children's wardrobes: a – hanging space for long and short clothes, China, 2023; b – folding clothes storage area, China, 2023; c – small item storage drawer, China, 2023



**Fig. 7.** Storage cabinet: a – fun storage, Spain, 2011; b – mobile storage, China, 2023

**Conclusions.** The article compares the physiological characteristics of children in different periods and summarizes the design requirements and methods for children's tables, chairs, beds, and storage furniture. Research has found that children's furniture can meet their physiological growth needs through different design methods, technical means, etc. If a set of furniture can accompany children from infancy to youth, it must be designed according to the characteristics of children's physical and mental development, considering

the needs of children at various stages of growth and development, paying attention to the growth of furniture, and the growth of children's furniture. Design will surely become the focus of children's furniture research. Of course, when designing and arranging the space, it is also necessary to comprehensively consider the physical and mental needs of children, and create a comprehensive, holistic, and multi-functional space. The combination of indoor space and children's furniture can create a good growth environment for children.



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## АНАЛІЗ КОНСТРУКЦІЙ ДИТЯЧИХ МЕБЛІВ З УРАХУВАННЯМ ФІЗІОЛОГІЧНИХ ЗМІН ДІТЕЙ

**Метою** дослідження є визначення потреб дітей і підходів щодо проектування дитячих меблів з урахуванням фізіології дітей; застосування екологічних концепцій дизайну в розробці нових конструкцій та аксесуарів з урахуванням вимог до дизайну дитячих меблів.

**Методологія.** У дослідженні використано аналіз літературних джерел з дизайну дитячих меблів, метод порівняльного дослідження, кейс-аналіз, структурно-функціональний аналіз, узагальнення результатів дослідження тощо.

**Результати.** Аналізуючи елементи дизайну меблів з точки зору дитячої фізіології, було виділено три категорії: дитячі столи та стільці, дитячі ліжка та дитячі меблі для зберігання речей. Згідно з вимогами до проектування дитячих меблів та системи «людина-машина», визначено, що висоту дитячих столів і стільців можна регулювати, а також можна змінювати кут між робочим столом і спинкою дитячого стільця. З ергономічної точки зору ці вимоги формуються з урахуванням росту, ваги та особливостей розвитку дитини. Визначено, що за допомогою стандартизованої конструкції дитяче ліжко можна зібрати або розібрати, відрегулювати висоту ліжка, а також поєднати комбінацію ліжка з іншими функціями. Визначено категорію меблів для зберігання дитячих речей, наведено їх класифікацію за різними ознаками та відповідно до вимог щодо зберігання певних видів предметів.

**Наукова новизна.** Досліджено вплив фізіологічних змін дитини на експлуатацію меблів, визначено вимоги для забезпечення задовільних умов використання меблів дітьми різного віку, водночас, надано конкретні дизайнерські ідеї.

**Практичне значення** отриманих результатів полягає в можливості їх застосування дизайнерами і виробниками при проектуванні дитячих меблів.

**Ключові слова:** дизайн; дитина; предметний дизайн; фізіологія; ергономічність; дизайн меблів; дитячі меблі; меблі для зберігання.

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