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Ergonomic suitability of special education kindergarten for children with special needs: pilot school example

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Abstract

Background The purpose of the study is to evaluate the ergonomic suitability of a special education kindergarten for children with special needs.

Methods In this study, special education kindergartens were evaluated in terms of ergonomic suitability, based on the structure and standards guidelines determined by UNICEF and the Ministry of National Education of the Republic of Turkey for schools and kindergartens for the disabled. As a result of the evaluation process, ergonomically unsuitable interior and exterior elements of the special education kindergarten were identified and these findings were presented in detail.

Results According to the evaluation results, it was determined that the classroom, lighting, parent waiting area, toys, toilet, cafeteria and security standards were not fully met in the interior, but the heating/cooling, ventilation and hygiene criteria were met. It was determined that the garden, ground and security features in the outdoor area met ergonomic standards, and that there were minimal deficiencies in the play and recreation areas.

Conclusions Universally accessible architectural designs should be made for all disability groups in special education kindergartens. In order for children to receive education in healthy, safe and comfortable conditions, teachers, school administration, health professionals, architects and engineers should come together to better identify the needs and plan interior and exterior designs. Future studies should focus on developing and validating standardized ergonomic assessment tools tailored to various disability groups in special education settings. Additionally, large-scale and multi-site research is needed to systematically evaluate kindergartens across different geographic regions and educational levels, thereby enhancing the applicability, inclusiveness, and generalizability of ergonomic standards.

Keywords Special education school, Kindergarten, Ergonomic, Child with special needs, Occupational therapy

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Introduction

The kindergarten environment is of critical importance in terms of children's learning processes and their ability to receive the necessary care [1]. This environment includes various elements, from colors to light, from sounds to the tools and equipment used [2]. In order to provide the best learning and care conditions for children, environmental features such as spaces, materials and equipment within the school may need to be rearranged [3].

If children are not raised in a healthy and safe school environment, their development may be negatively affected [4, 5]. Students, especially in kindergartens, may face a number of hazards due to classroom designs that are often unsuitable for learning and care [6]. This may cause children to face risks of falling, slipping, crashing and getting injured while using school spaces. Additionally, inadequate development of sensory and physical skills may cause children to fail to recognize dangers and thus become vulnerable to accidents [7].

When preschool-aged children's playgrounds and equipment are subjected to an ergonomic evaluation, the safety and health of children can be protected by minimizing the risks of injury, unsafe movements, uncomfortable positions and other potential hazards [8]. Additionally, toilets in kindergartens are very important for the health and safety of children. Therefore, the planning and design of the construction phase of kindergartens should be carried out with great care and attention, taking into account the well-being and safety of children [9]. If the kindergarten is designed as an area suitable for learning, children's development can be supported from an early age [10].

There are a limited number of studies in the literature evaluating the ergonomics of preschools where typically developing children are educated [11, 12]. One of these studies emphasizes that non-adjustable furniture used in preschools can negatively impact children's learning [12]. Another study conducted in Ghana reported that preschool buildings were either very old or poorly constructed, posing a serious safety risk for students [11]. Furthermore, it emphasizes that the participation of children with special needs in school may be limited by physical environmental conditions, and therefore, the need for careful planning and ergonomic evaluation of environmental arrangements in institutions where these children are educated [13]. However, a review of the existing literature revealed no studies evaluating the ergonomic suitability of special education preschools, where children with physical, cognitive, visual, auditory, and speech disabilities are educated together, for all children. Based on this, the purpose of this research is to examine the ergonomic suitability of a special education kindergarten where children with special needs and different types of disabilities receive education together.

Material and method

Study design

This study was designed as a descriptive, observational investigation to evaluate the ergonomic characteristics of a special education kindergarten. No intervention was conducted; instead, the ergonomic features of the kindergarten were systematically observed in accordance with relevant standards. Ethical approval was obtained from the Scientific Research Ethics Committee of Lokman Hekim University on October 23, 2023, with decision number 2023/190. The evaluation was carried out in March 2024 by the Department of Occupational Therapy at the Faculty of Health Sciences, Lokman Hekim University, and was conducted in accordance with the principles of the Declaration of Helsinki. In addition, written permission for the assessment of the school was obtained from the school principal.

The selected special education kindergarten, located in Ankara, serves as a pilot implementation model, designed in line with inclusive education principles and universal accessibility standards to accommodate children with various disabilities, including physical, intellectual, visual, auditory, and speech impairments. It was selected for this study due to its high representational value and potential for enabling comparative analyses with similar institutions. Accordingly, the school constitutes a meaningful and appropriate case for a comprehensive evaluation that reflects a child-centered design approach. The school provides education for children aged 4 to 6 years from different disability groups. The evaluation process was structured in accordance with national and international guidelines and conducted following a systematic observation protocol.

Assesments

In this study, the ergonomic suitability of the special education kindergarten was evaluated using a structured on-site observation method. Since no single guideline fully encompasses all ergonomic components, multiple national and international sources were simultaneously referenced. This approach enabled a comprehensive and multidimensional analysis of environmental factors. The evaluation process was based on the School Accessibility Guide for Children with Disabilities published by UNICEF [14], the Preschool and Primary Education Institutions Standards Guide developed in collaboration between the Ministry of National Education (MNE) of the Republic of Turkey and UNICEF [15], and the Minimum Design Standards guide for Educational Facilities created by the MNE of the Republic of Turkey [16]. Additionally, the academic book Ergonomics for Children [17] and scientific studies on kindergarten ergonomics in the literature [18–20] were included in the assessment process.

The ergonomic evaluation was conducted within the framework of physical structural features, equipment suitability, safety, environmental accessibility, and child-centered design principles. This included interior elements such as classrooms, furniture, toys, resting areas, lighting, flooring, toilets, cafeteria, infirmary, corridors, stairs, parent waiting areas, and general hygiene practices. For the outdoor environment, elements such as garden design, playgrounds, open resting areas, ground surfaces, and safety measures were observed.

The evaluation was carried out simultaneously by an occupational therapist experienced in ergonomics and a physiotherapist specialized in the field of occupational therapy. The observation, which lasted approximately 2.5 h, covered all interior and exterior areas of the school. The observation was conducted on a regular weekday while the students were actively engaged in educational activities, allowing the school to be assessed under natural usage conditions. Each area was systematically examined according to the criteria specified in the relevant guidelines. The findings were documented in writing and supported by 160 high-resolution photographs taken with a mobile device equipped with a 12-megapixel camera. The data obtained were compared and jointly evaluated by the researchers, and the opinion of a third, independent researcher who did not participate in the observation was also sought to reach a consensus. Any inconsistencies were resolved through collaborative assessment. This method ensured that the evaluation process was systematic, reliable, and transparent. The findings were reported in detail through text, tables, and visual materials.

School accessibility guide

This guide was created by UNICEF within the scope of "Making Schools Accessible for Children with Disabilities" and was prepared to assess the accessibility status in schools for children with disabilities. The guide presents the requirements for making schools safe, accessible and compliant with ergonomic standards for children with disabilities. This guide includes the school's standards regarding entrances, ramps, stairs, corridors, signs, doors, classrooms, boards, tables/desks/chairs, storage areas, windows, flooring, toilets, play areas and lighting [14]. In line with these headings, the special education kindergarten was assessed in terms of accessibility and ergonomic suitability and the areas that were not suitable were determined.

Preschool and primary education institution standards guide

This guide was prepared in 2015 by the Ministry of National Education of the Republic of Turkey and UNICEF in order to determine the accessible standards of schools for all children. The guide is a guide that presents the location of preschool education classes, lighting, physical and structural features, security measures, entrance and exit arrangements, security of the school environment and the necessary standards for children with special education needs [15]. In the study, private kindergartens were evaluated according to this guide and inappropriate areas were determined.

Education facilities minimum design standards guide

This guide was prepared by the Ministry of National Education of the Republic of Turkey in 2015 to determine the physical suitability standards of educational buildings. The guide defines in detail the suitability standards for interior and exterior building components of schools such as classrooms, lighting arrangements, security measures, playgrounds, management units, dining areas, entrance and exit arrangements, toilets, sinks, accessibility elements and building materials used [16]. For the study, the special education kindergarten was evaluated according to this guide and structures that did not meet the ergonomic standards were identified.

Data analysis

The entire analysis process was collaboratively conducted by two researchers who participated in the evaluation phase and a third researcher who was not directly involved in the observation. This three-tiered data review approach enabled an objective, multidimensional, and holistic assessment of the findings, and final decisions were made through consensus.

The analysis was carried out systematically, content-based, and in multiple stages, using written evaluation notes recorded during observation and the visual data collected. A total of 160 high-resolution photographs were taken during the evaluation. These photographs were reviewed for content and technical quality (e.g., resolution, lighting, angle), and those deemed insufficient or unrelated to the evaluation criteria were excluded. Suitable images were matched with the corresponding observation areas and cross-checked against written findings. Written and visual data for each evaluation area were analyzed concurrently, ensuring consistency and integrity across different domains. During the analysis and presentation of visual materials, BioRender software was used; images were merged and customized when necessary for area-specific visual representation.

The analyzed data were classified under two main categories: indoor and outdoor components. The indoor evaluation included classrooms, furniture, toys, resting areas, lighting, flooring, toilets, cafeteria, health room, corridors, stairs, parent waiting areas, and general hygiene practices. The outdoor evaluation covered garden design, playgrounds, outdoor resting areas, flooring, and safety measures. All data related to these areas were

assessed based on ergonomic suitability and categorized as "appropriate," "partially appropriate," or "not appropriate." The analytical findings were presented using tables and explanatory visuals supported by color codes (green (+), yellow (–), red (×)). The data analysis process was completed in a systematic, transparent, and multi-phased manner, and the results were reported in detail through text, tables, and figures.

Results

Interior design

The kindergarten evaluated had 5 classrooms, 1 dining hall, 1 infirmary, 2 student and 2 teacher toilets. The total number of students in the kindergarten was 28 and the classroom surface area was suitable for the number of students in the classrooms (Fig. 1).

Classrooms

Tables Some of the tables had adjustable height, their corners were ovalized and there were no broken or unusable parts. In addition, the tables were light enough to be carried and were made of wood. It was determined that some of the tables were partially suitable ergonomically with these features. It was determined that some of the tables did not have plastic covering on their legs and created excessive noise for the hearing impaired. In addition, the tables did not meet the standards for children with special needs because they were not in a contrasting color for children with low vision and did not have an inclination feature (Fig. 2a and b) (Table 1).

Chairs It was determined that the chairs were not ergonomically suitable for children with special needs. The chairs did not have head, torso, leg and foot support, and these areas were not adjustable. In addition, the chairs did not have a reclining feature, a body belt, wheels for movement, or safety equipment for children who did not have good head control and sitting balance. It was observed that some chairs did not have plastic coverings on their legs to prevent hearing loss (Fig. 2a, b and c) (Table 1).

Wall features The wall height was in accordance with the standards. The colors of the wall were painted using erasable paint in a light tone so as not to distract children, and it was water-based, which does not harm health. Panels, frames and similar materials were placed securely on the wall. Additionally, there was sound and heat insulation



Fig. 1 School interior architectural plan

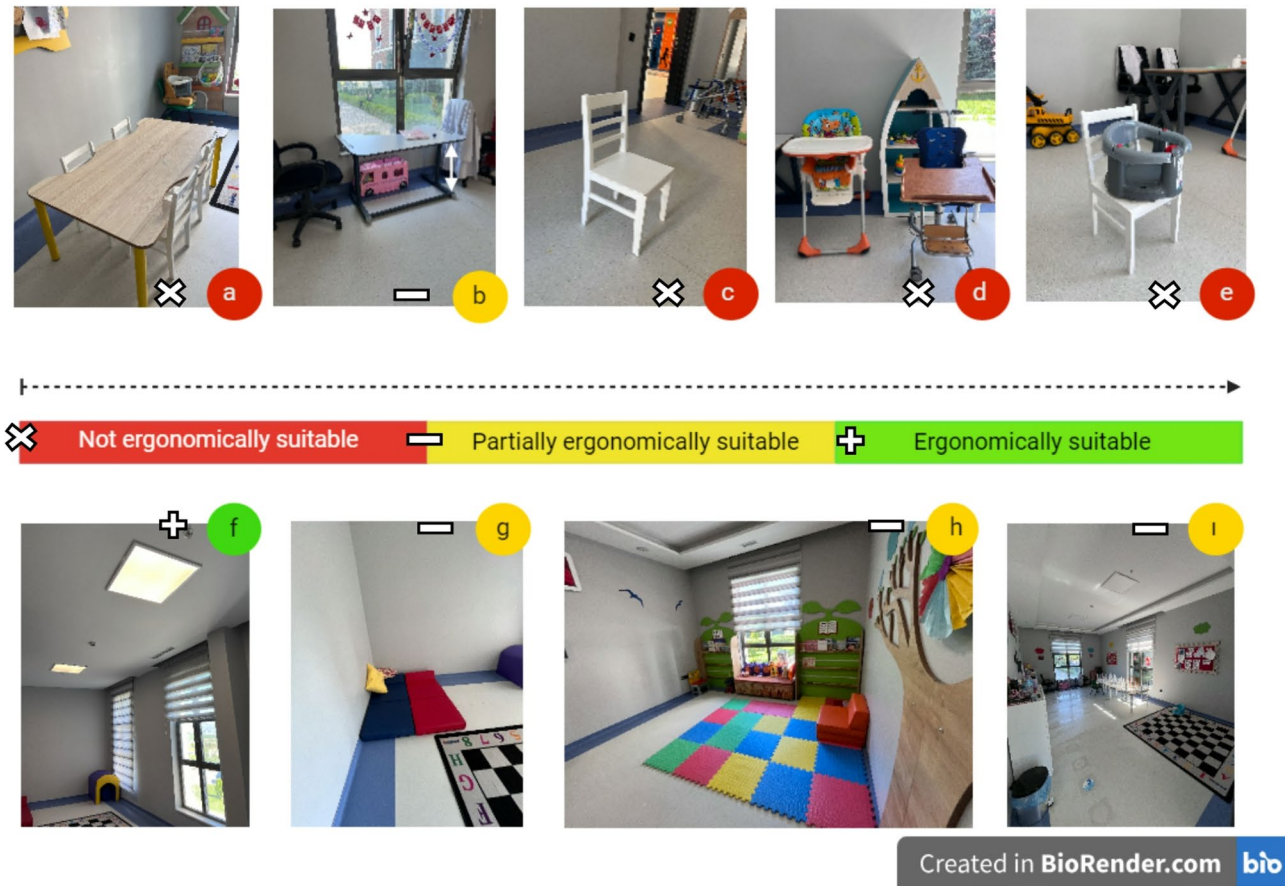


Fig. 2 Classroom materials and design

on the exterior walls. With these features, the walls were ergonomically compatible with the standards. However, there was no contrast colored strip guide on the wall for children with low vision. The interior walls had noise-absorbing sound insulation for the hearing impaired (Table 1).

Cabinets and bookcases Cabinets and bookcases are fixed to the wall to prevent the risk of tipping over (Table 1).

Floor structure The entire kindergarten is covered with anti-bacterial PVC floor. The floor structure had a suitable structure in terms of hygiene and slip resistance. However, there was no large soft floor covering such as rubber or floor cushion for children with special needs in the classrooms (Fig. 2g and h, ı) (Table 1).

Rest areas The areas where children with special needs could sit and lie down to sleep were not ergonomically adequate. Only some of the classrooms had protective floors made of carpet or rubber material. There was no special area for children to sleep in these areas on the floor (Fig. 2g and h, ı) (Table 1).

Lighting Natural lighting: All areas of the kindergarten had large window designs architecturally. With these features, adequate lighting was provided during the day (Fig. 2c) (Table 1).

Night lighting All areas of the kindergarten are illuminated with daylight spot lamps in accordance with the standards. The lighting system, which is automatically activated in case of power outages, is positioned to cover all areas of the school. The light switches were located high from the floor and did not comply with standards because children (with or without TS) could not use them independently (Fig. 2c) (Table 1).

Toys

The toys were generally found to comply with the standards in terms of durability, construction material and safety, but broken and missing parts were detected in some toys. However, it was observed that there were no toys with increased contrast for children with low vision (Fig. 3a) (Table 2).

Table 1 Ergonomic analysis data regarding classroom, classroom equipment and lighting

Interior design	Ergonomic suitability
Classrooms	
The height of the table can be adjusted.	-
The tilt of the table cannot be adjusted.	x
The table and chair are not broken, cracked or rough and corners are rounded.	+
The table and chair material is wood and is portable and light.	+
There were partially noiseless tables and chairs for the hearing impaired.	-
There are no tables or chairs in different color designs for children with low vision.	x
Chair sections are not adjustable (height, tilt, foot, body and head support adjustment).	x
The chair does not have any support equipment (foot, body, head and leg support).	x
Wall (ceiling) heights are at least 270 cm.	+
The intersecting areas of the walls are rounded in some places.	-
Wall colors are light colors that will not tire the eyes.	+
Water-based and wipeable paints were used on the walls.	+
There is no contrasting color strip on the wall for children with low vision.	x
Pictures, panels, frames and similar materials on the wall are properly fixed.	-
There is sound and heat insulation on the external walls.	+
There were no coatings on the interior walls that reduce noise and provide sound acoustics.	x
Cabinets and bookcases are fixed to the wall.	+
Children's sleeping areas (room, bed and the floor on which the bed will be placed) are not sufficient.	-
There is not enough seating area (sofa or on the floor) for children to rest.	-
The floors of classrooms and other areas are made of antibacterial PVC floor material.	+
Some of the classrooms are partially covered with carpet or rubber material.	-
There are no protective devices for the hard corners of furniture.	x
Lighting	
Daytime lighting is sufficient.	+
Spot lamps (fluorescent and bulbs should not be used) were used for night lighting.	+
The light switches are placed too high for children to reach.	x
There was an automatic lighting system and generator against power outages.	+

Green (+): Ergonomically suitable, Yellow (-): Partially ergonomically suitable, Red (X) : Not ergonomically suitable

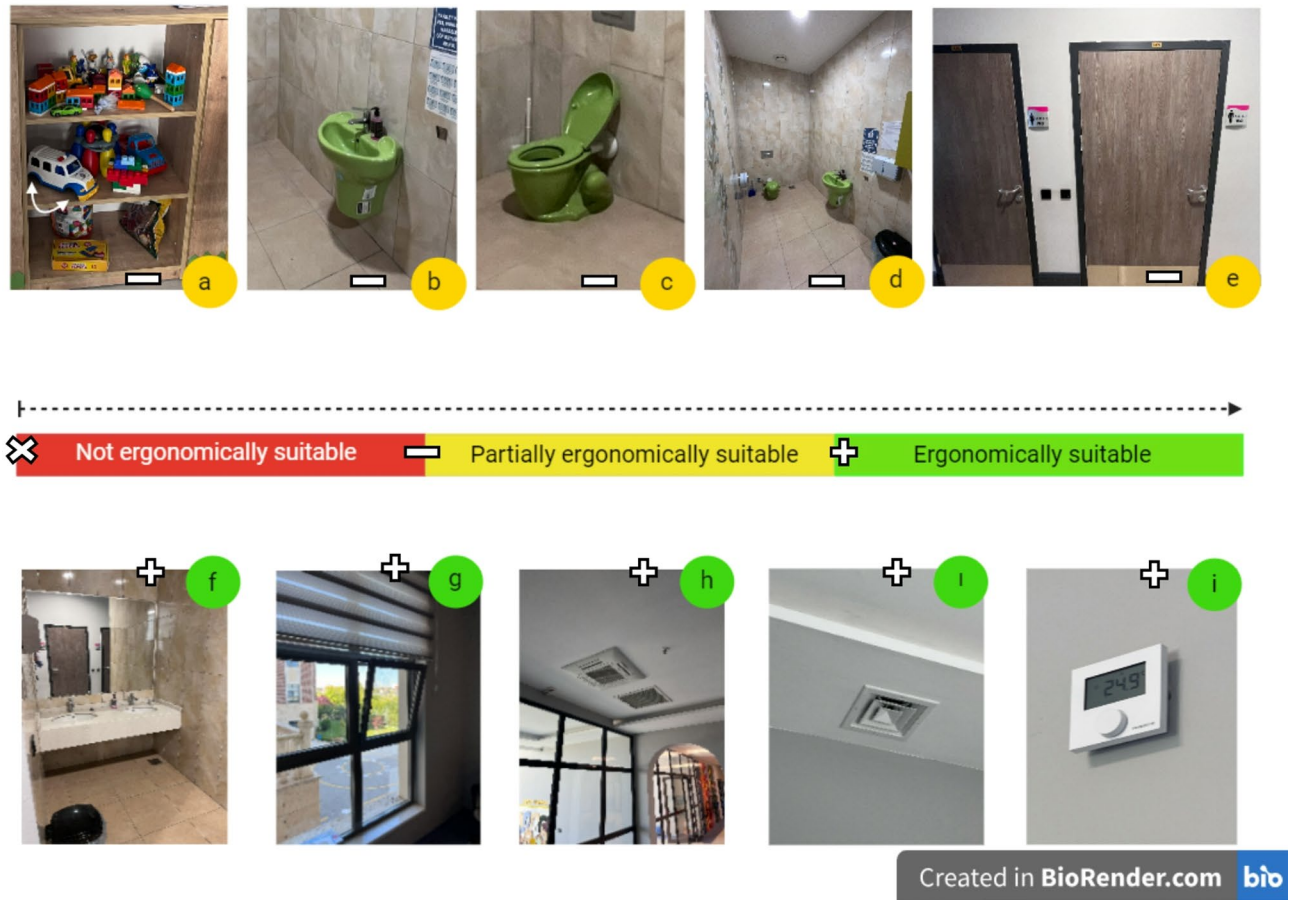


Fig. 3 Toys, toilet sink and heating/cooling and ventilation

Toilets

Toilets are large enough to be used by children with special needs. However, there were no grab bars around the toilet and sink. It was observed that the number of toilets, their usage area, compliance with TS, safety and design were ergonomically appropriate, but they did not comply with the standards in terms of the absence of an emergency warning system (Fig. 3b, c, d, e and f) (Table 2).

Heating/cooling and ventilation The kindergarten was heated and cooled by a central system. The temperature is adjusted according to seasonal standards. In the evaluation of the heating and ventilation system, it was determined that it met the standards in terms of ergonomics (Fig. 3g and h, ı, i) (Table 2).

Dining halls

Although the dinning room was located one floor below the kindergarten floor, it was determined that it was not far in terms of distance. For children who cannot use wheelchairs or go up and down stairs, there was an elevator that could accommodate 8 people at the same time. The tables and chairs in the dining hall were not ergonomically suitable for children with special needs (Fig. 4a, b and c) (Table 3).

Stairs and corridors In the evaluation, it was seen that the width and step height of the stairs were in accordance with the standards. It was determined that the steel railings were designed with narrow spacing, had grip surfaces at short and long heights for people of different heights, and were suitable for safety. In addition, it was determined that the presence of grab bars on the walls of the stairs and the corridors being sufficiently wide were in compliance with the standards. The corridors were in compliance with the standards in terms of width, length and grab bars. However, it was determined that the lack of contrast-enhanced strips on the stairs and the lack of a covered bottom of the stairs were not ergonomically suitable for children with low vision (Fig. 4e and f) (Table 3).

Parent waiting areas It was determined that parents of children with special needs accompany their children at school during educational hours. The area designed for parents to wait and rest was not comfortable enough to wait for a long time (Fig. 4g) (Table 3).

Table 2 Ergonomic analysis data on toys, toilets, heating/cooling and ventilation

Interior design	Ergonomic suitability
Toys	
Toys are resistant to breakage or splintering (they are sturdy).	-
There are no small parts among the toys that carry the risk of swallowing.	+
There are no sharp and stinging parts (splinters, cables, staples, needles, etc.).	+
The materials of their toys (wood, healthy fabric, plastic that is not too soft or hard, metal that is not too heavy and hard) is suitable and the seams are solid.	-
The toys are portable and lightweight and there is a statement (symbol, text, sign) on the toys showing that they do not contain lead paint.	+
Toys do not contain explosives and flammable materials.	+
Water-based paint was used in the construction material of the toys. The toys are rust-free. Plastic toys are odorless.	+
Glass or ceramics are not used in the building material of the toys.	+
The battery sections of the toys are closed with screws. There is no discharge of chemicals (mercury, aluminum, cadmium). Toys with batteries are at 24 V and below.	+
There are no toys with contrasted colors for children with low vision.	x
Toilets	
The number of toilets and sinks is sufficient.	+
Toilet bowl and sink heights are suitable.	+
The width of the toilet and sink area is wheelchair accessible.	+
The floors of the toilet and sink are non-slip ceramic.	+
Toilets and sinks have lever-type faucets.	+
Liquid soap can be used easily.	+
Toilets and sinks do not have grab bars and an emergency alarm system.	x
Toilet doors do not lock from the inside and open outward.	+
Heating/cooling and ventilation	
Heating (underfloor heating) / cooling (air conditioning) is provided by a central system, the ambient temperature is 19-20 ^{0}C.	+
The heating system is protected against impacts, injuries and external interventions.	+
In areas with windows, ventilation is adequately provided.	+
The kindergarten has a central ventilation system.	+

Green (+): Ergonomically suitable, Yellow (-): Partially ergonomically suitable, Red (X) : Not ergonomically suitable

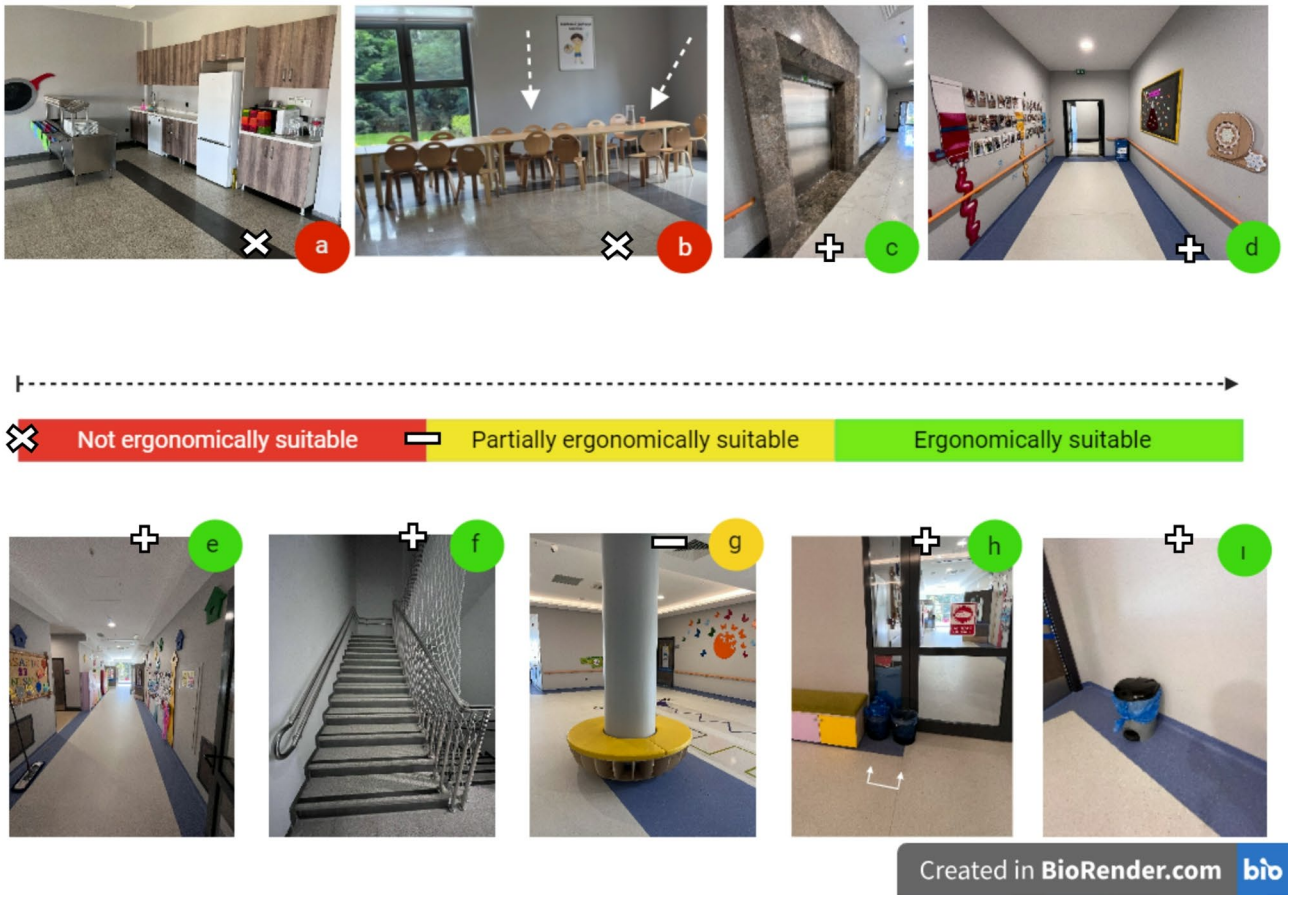


Fig. 4 Dining hall, staircase, corridor and parent waiting area

Hygiene The area where the kindergarten was located had a 3-stage transition system. First, entrance is provided to the kindergarten building, and then, in the 2nd stage, there is a special door to access the restricted area of the kindergarten. A hygiene area has been created to ensure hygiene standards by entering this area without shoes or wearing overshoes. In addition, it was determined that the garbage bins were emptied regularly, disinfectants were available in the corridors, and general cleaning was carried out on a daily basis to ensure that the school had standards appropriate to its general hygiene (Fig. 4h, ı) (Table 3).

Security

Windows The windows are positioned at a height of 60 cm from the floor in accordance with the standards. In addition, the opening parts of the windows are at a height that children cannot reach, their handles are kept in a separate place that only the teacher can access, and they are designed to open semi-opening (from the top). The windows consisted of double glass, which provides special heat and sound insulation. These features were found to be in compliance with the standards, but it was determined that the absence of a protective railing outside the window created a serious security risk and was not in compliance with the standards (Fig. 5a) (Table 4).

Doors There was a barrier to prevent children's hands from getting stuck in the doorways and a special device to prevent the door from closing completely when the teacher was not in the classroom. There was no threshold at the door entrances, the door was single-leaf, not sliding, and opened outward (Fig. 5b and c) (Table 4).

Electrical wiring and installations Some sockets were located at a height out of reach of children, some were located within their reach and did not have protective covers. The electrical cables were designed to be hidden with channels, but the switch control panels were not locked with the switch (Fig. 5e) (Table 4).

Furniture All furniture is fixed to the wall for security purposes. However, it was observed that furniture with sharp corners did not have protective corners (Fig. 5d and g) (Table 4).

Table 3 Ergonomic analysis data on dinning hall, stairs and corridors, parent waiting areas and hygiene

Interior design	Ergonomic suitable
Dinning hall	
The chairs are not adjustable and the chairs do not have support apparatus.	x
Part of the table can be adjusted in height, but not in tilt.	-
There are no ergonomic kitchen utensils (thickened forks, spoons, glasses, etc.).	x
For children with low vision, there are no contrast-enhanced plates, forks, freaky glasses, etc.	x
Stairs and corridors	
The width of the stairs (at least 120 cm) and the height of the steps (15 cm) are suitable.	+
There are grab bars on the wall side of the stairs.	+
The height of the grab bar on the stairs (76-90 cm) is suitable.	+
There are no strips on the stairs so that they contrast with the floor.	x
The gaps under the stairs are not closed.	x
The width of the aisle (at least 120 cm) is suitable.	+
There are grab bars in the aisles (the diameter should be 38 mm-45 mm in diameter).	+
The administrative staff and teachers' room is close to the classrooms.	+
There are guide signs indicating location on the floors.	+
Texts and figures indicating location and location within the school are not written in Braille alphabet.	x
Parent waiting areas	
There are seats but no tables and partially comply with the standards.	-
Hygiene	
Entrance, classroom and toilet hygiene are up to standard.	+
There is disinfectant in the classrooms and corridors.	+
Shoes are not allowed in the kindergarten area (galoshes, slippers, booties, etc. are used).	+
Garbage bins are large enough and have closed mouths.	+

Green (+): Ergonomically suitable, Yellow (-): Partially ergonomically suitable, Red (X) : Not ergonomically suitable

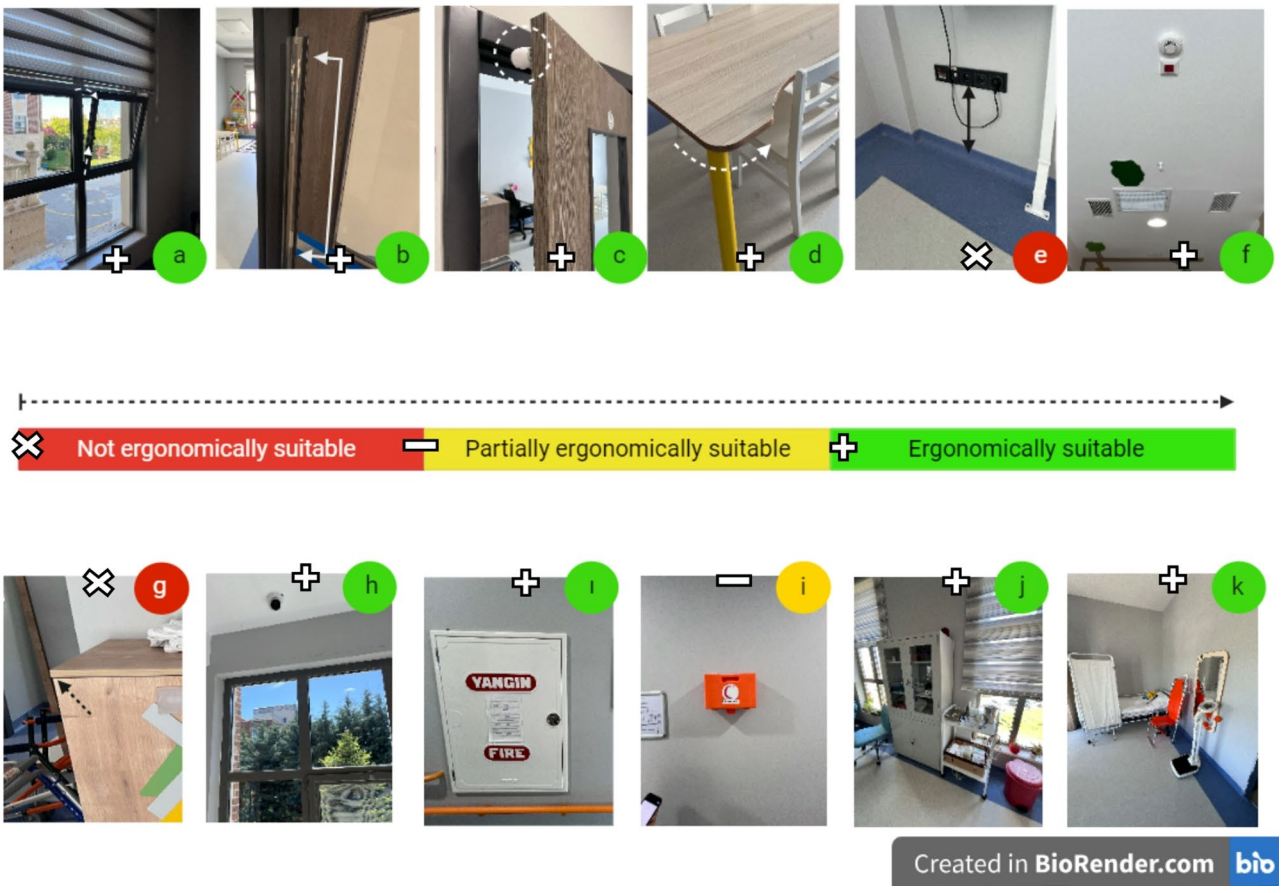


Fig. 5 Security systems and infirmary area

Other areas of security It was determined that the kindergarten had an emergency exit door, fire escape, fire extinguishing system and a sound system that allows announcements to reach everyone simultaneously (Fig. 5f and h, ı, i) (Table 4).

Infirmary and health safety

It was determined that the kindergarten had an infirmary and a nurse working in the infirmary. In addition, it was determined that there was no first aid kit in each classroom. However, it was seen that there was a first aid kit and oxygen tank in the common area. There were no artificial odors in the classrooms and common areas (Fig. 5j and k) (Table 4).

Outdoor design

Garden

It was seen that the landscaping and afforestation of the school garden were done in accordance with the standards and the green area in the garden was well-maintained. In addition, it was seen that the transition between the garden and the school, the playground and the sink was easy. There were steps in these transitions, and since the ground was flat, a ramp was not needed (Fig. 6d, e, f, g and h) (Table 5).

Play ground

It was determined that the construction materials, dimensions and safety measures of the playground, slides and swings were suitable for children with typical development. However, it was found to be unsuitable for use by physically and/or visually impaired/low vision children. It was found that there were no guidelines or contrast-enhanced signs for blind/low vision children. For physically disabled children, it was concluded that the slides were not ergonomic due to the lack of ramp exit systems instead of stairs and the swings having insufficient protective belts and supports (Fig. 6a, b and c) (Table 5).

Floor

The floor structure of the outdoor space was found to be suitable in terms of building material and design (Fig. 7a and b) (Table 6).

Table 4 Ergonomic analysis data on safety and health security

Interior design	Ergonomic suitable
Security	
The size (25-50% of the room floor surface) and design of the windows are appropriate.	+
The window height is 60cm (lower edge)-145cm (upper edge) from the floor.	+
The windows have sound and heat insulation.	+
There are no grille lattice railings on the windows.	x
The windows open inwards.	+
The opening handles of the windows are kept by the teacher.	+
Transoms (on the window) have a semi-opening mechanism.	+
There are equipment at the doors to prevent closing and shaking hands.	+
The doors are wide enough for TS passage.	+
The door handle is easy for the child to hold and open.	+
The doors are single-winged and open outwards, there are no sliding doors.	+
There are no thresholds on the doors.	+
For children with low vision, the window/door handle is not covered in a contrasting colour.	x
Some of the electrical sockets are at a height that children cannot reach (1.50 cm).	-
Electrical sockets do not have protective covers.	x
The electrical wiring is partially hidden by conduit, but the switch panel is not locked.	-
There is no protective silicone on the hard cornered parts of the furniture.	x
There is an emergency exit door.	+
There is a fire escape.	+
There is a fire extinguishing and alarm system.	+
There are security cameras in non-classroom areas.	+
There is a megaphone sound system in the interior.	+
Infirmary and health safety	
There is an infirmary/health room and the room has adequate equipment.	+
There are no synthetic air fresheners in classrooms and rooms.	+
There is an oxygen tube and mask.	+
There is a first aid kit in the common areas, but not in the classrooms.	-

Green (+): Ergonomically suitable, Yellow (-): Partially ergonomically suitable, Red (X) : Not ergonomically suitable



Fig. 6 Play ground and garden design

Rest area

There was an open and closed recreation area in the garden. Upon examination, it was seen that the open-covered benches and covered camellias in the garden were suitable for children and adults without physical disabilities, but were not suitable for children with physical disabilities (Fig. 7c and d) (Table 6).

Security

It was observed that the kindergarten meets high-security school standards with features such as having a security guard at the entrance to the school garden, the height of the garden walls, the absence of pits and construction debris that may pose a danger, good lighting, and the parking lot being located in a separate area (Fig. 7e, f, g and h, ı, i) (Table 6).

Discussion

According to the evaluation results, it was concluded that all classroom, lighting, toys, toilet, parent waiting area, cafeteria and security standards were not met in the interior and the criteria of heating/cooling, ventilation and hygiene standards were met. In the outdoor area, it was determined that the garden, ground and security features met ergonomic standards, but there were minimal deficiencies in the play and recreation areas. Considering the interior and exterior spaces, it was concluded that the kindergarten did not have sufficient ergonomic standards for low vision and visually impaired individuals.

Kindergarten tables and chairs should be wooden and lightweight for health and usability. To ensure ease of vision for children with low vision, furniture surfaces should be covered with a contrasting surface [21]. By arranging classroom furniture, hearing-impaired individuals should be able to communicate easily and participate in activities. Any sound-blocking material must be attached to the legs of tables and chairs [22]. It is known that children with special needs and physical disabilities may have disorders in their sitting posture and that this is associated with inadequate head control and trunk muscle strength. For this reason, the necessity of adjustable chair and table mechanisms with different personalized supports has been revealed [23]. In our study, it was determined that the chairs in the kindergarten were wooden and light, but they did not have supports such as body, hip and head and did not have adjustable features. It was observed that the tables only had height adjustment. Kindergarten tables and chairs for children with

Table 5 Ergonomic analysis data on the garden and play ground

Outdoor design	Ergonomic suitable
Garden	
There are grass and tree-planted landscaped areas in the garden.	+
There are no trees at risk of collapse or plants at risk of sinking.	+
Access from the garden to the school, playground and sinks is easily achieved.	+
There are no steps to pass from outside the school to the garden and from the garden to the inside of the school (the passage is straight and does not require a ramp).	+
Play ground	
Swings and slides are durable, well assembled and in working order.	+
Slide and swing paint is heat resistant.	+
The railings of the slides (height 150 cm, width 40 cm) are one piece.	+
Steel/iron was preferred instead of wood and plastic in the construction material of the slide and swing.	-
Slides and swings are not suitable for use by children with physical disabilities and low vision.	x
The swing chain is large enough for the child's fingers to fit in.	+
Slides and swings are positioned so as not to pose a risk of collisions and accidents.	+
The distance between the slide's deceleration mechanism and the ground is 30 cm.	+
The diameter of the swing chains (0.6 cm) and the length of the hanging iron (300 cm) are suitable.	+
Swings do not have seat belts.	x
The swings are closed on 3 sides.	+
The height of the swing from the ground (higher than 35 cm) is appropriate.	+
There is a statement that the paints used in swing coloring contain lead.	+
The playground floor is covered with rubber and soft ground instead of filling materials such as sand and pebbles.	+
Apart from the playground, there is a free play area (general games, sports games, etc.).	+

Green (+): Ergonomically suitable, Yellow (-): Partially ergonomically suitable, Red (X): Not ergonomically suitable

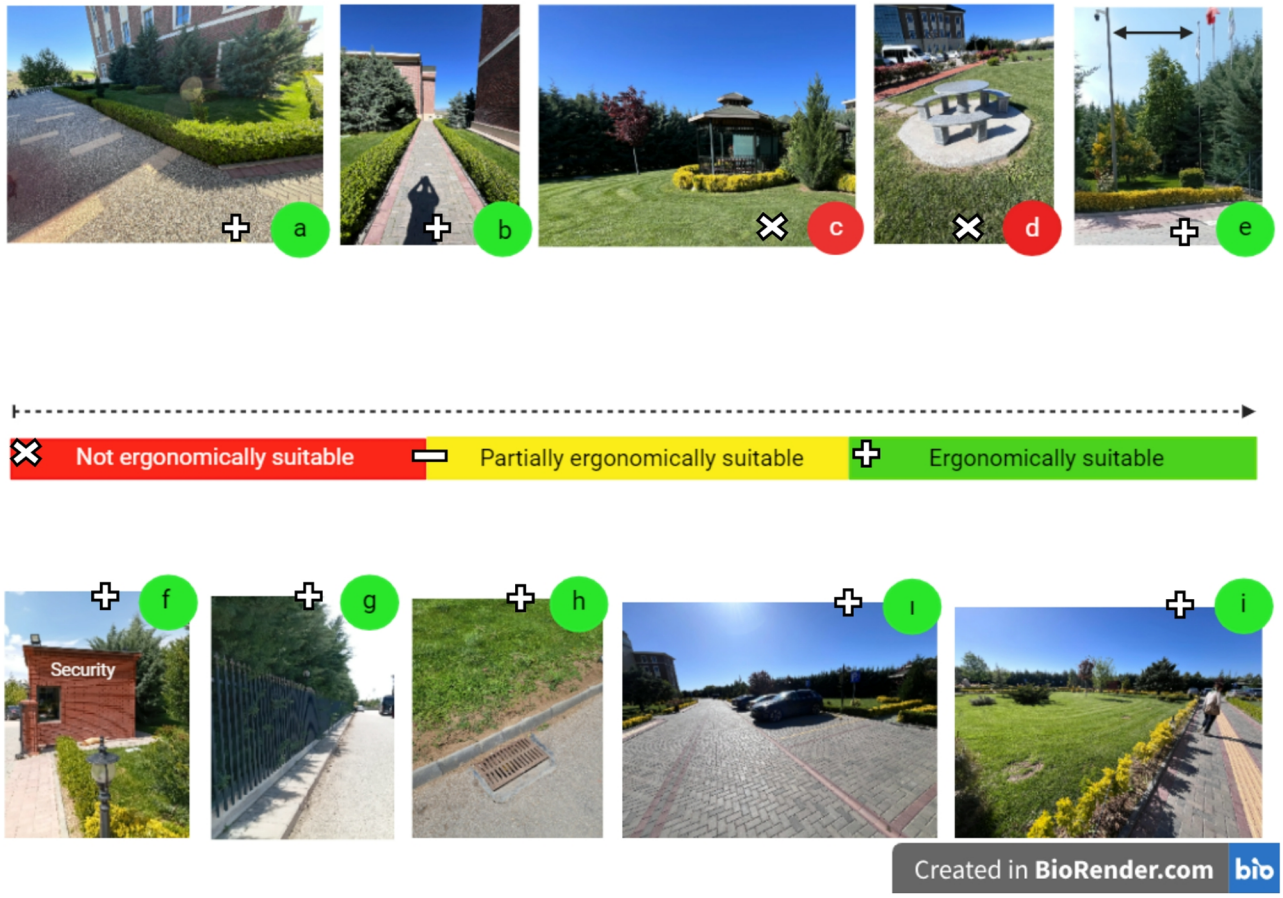


Fig. 7 Outdoor ground, rest area and safety equipment

special needs must have a dynamic module that is adjustable and includes support apparatus, as opposed to being static according to the child's support needs [24]. In addition, it is thought that coatings that will prevent disturbing sounds for the hearing impaired and contrast surface designs for children in different disability groups such as low vision should be applied to tables, chairs and all areas of the venue [25].

It is stated that ensuring structural standards such as wall size, paint and insulation for kindergartens and covering sharp corner sections with protective coatings are important determinants of safety [26]. In our study, it was seen that the wall dimensions, color/paint, sound and heat insulation features of the kindergarten classroom were in compliance with the standards. However, it was determined that the kindergarten did not comply with ergonomic standards because the sharp cornered parts of the wall and furniture were not completely ovalized and the contrast colored guide strip on the wall for children with low vision was not made. Although there were exterior sound-absorbing coatings on the outside of the walls for the hearing impaired, there were no noise-absorbing and acoustic-optimizing coatings on the interior walls. In order for children with low vision to continue their safe independent movement, all areas should be covered with wall strips with increased contrast, and sharp places on the walls should be covered with protective equipment to reduce the risk of children being injured [27]. When making classroom arrangements for hearing-impaired individuals, attention should be paid to acoustic properties. It is important to use extra acoustic insulation materials to reduce the noise level and to ensure that sounds are heard more clearly by arranging the acoustics of the classroom [22].

Since children with special needs are at risk of health problems, anti-bacterial PVC coatings must be used on school floors to ensure hygiene [28]. In addition, children with physical disabilities who cannot walk in kindergarten may need a space to move and rest on the floor because they cannot sit all day [29]. According to our evaluation results, the kindergarten's floor is ergonomic as it is covered with anti-bacterial PVC. However, it has been determined that carpet and rubber materials are locally present in some areas on top of PVC coating in the classrooms. It was observed that the classrooms were covered for sitting, sleeping and resting purposes,

Table 6 Ergonomic analysis data on the floor, rest area and safety

Outdoor design	Ergonomic suitable
Floor	
It has a concrete walking area and is covered with non-slip and non-shiny paving stones.	+
The walking area is stable and safe (suitability of gravel, stones and paving stones, etc.).	+
Rest area	
There are open and closed seating areas in the garden and these areas are solid.	+
The open and closed seating areas in the garden are suitable for parents, but are not suitable for children with special physical disabilities.	-
Security	
There is a security booth and guard at the garden gate.	+
The garden wall is durable and surrounded by concrete, iron or green fence insert.	+
The garden wall is at a height that children cannot reach (at least 1.80 cm).	+
The garden gate has a height (at least 180 cm) and a mechanism that cannot be opened by children.	+
Flagpoles are securely fixed.	+
The ventilation gap and water channels in the garden are closed with strong iron bars.	+
Garden water drain channels have good drainage system.	+
Rusty nails, iron, etc. in the garden. There are no construction remains.	+
There are sufficient number of lidded garbage and recycling bins in the garden.	+
There is a passageway and parking lot for vehicles independent of the pedestrian path.	+
Garden lighting is suitable. There is a guide path for the visually impaired in the garden.	+
There is an outdoor megaphone sound system.	+

Green (+): Ergonomically suitable, Yellow (-): Partially ergonomically suitable, Red (X): Not ergonomically suitable

but these resting and sleeping areas were of insufficient size and standards. Considering that children studying in kindergarten have different degrees of physical disabilities and some cannot walk, the need for children to sit, lie down and move around on the floor may arise. It is thought that there should be large areas on the classroom floor covered with standard seats, rubber and carpets to meet these needs of children [14].

In schools, the window size determined according to the classroom area is decisive for daytime lighting. Night lighting is determined by the classroom area and the size, power and number of lamps [30]. It has been shown that lighting is important both for the vision quality of children with low vision and for safety against situations such as falling. In addition, it was emphasized that light switches should be at an accessible height so that children can use the lighting independently [31]. Another study stated that schools should have power supplies against power outages. It has been observed that day and night lighting is sufficient in all classrooms and kindergartens, there is a lighting and generator system against power outages, but the light switches are at a height that children cannot reach. In order to ensure children's full independence in schools, light switches must be placed by taking into account their TS, grade and age status [32].

It is known that toy choices are very important in terms of health and safety, as children in kindergartens often play with toys, unlike other classes. It has been stated that it is important for toys to be durable, not to be torn, not to contain chemical dyes, and considering the possibility of children putting them in their mouths, toys should not contain small parts [33]. In the literature, it has been emphasized that toys should be designed with coatings containing contrasting colors such as black and white, or with identification embossing for visually impaired children, so that children with low vision can perceive or see better [34]. In our study, it was determined that the toys generally met the standards in terms of durability, material they were made of, and safety, but there were no special toys with increased contrast for children with low vision or reliefs for the visually impaired. In kindergartens, toys that are sturdy and do not pose a safety risk should be selected for each disability group [19, 35].

It has been stated that kindergarten toilets should be designed according to the size of the children, considering support and safety measures [36]. It was observed that the toilets and sinks were in compliance with the standards in terms of number and size, but there was no grab bar or emergency alarm system that would be required in case of falls or similar emergencies. The design of kindergarten toilets is thought to be important in terms of children's safety and ability to perform self-care activities independently. Additionally, safety equipment such as an emergency system should be included in the kindergarten design [11].

Ambient temperature is important because children may be affected by temperature changes and cause them to get sick. Natural and artificial ventilation systems are of great importance in kindergartens in terms of providing clean air in the environment according to seasonal conditions [37]. In kindergartens, heating, cooling and ventilation are provided by a central system in accordance with the standards, and in places with windows, ventilation is also provided through windows. These systems should be made in accordance with standards so that children with special needs in kindergarten can receive education in a healthy environment [38].

Feeding with correct positioning is vital for special needs preschool children who have swallowing and chewing problems and who do not have good trunk balance. It has been stated that the tables, chairs and eating utensils required for these children should be adaptable for these children [39]. It was determined that the dining hall was one floor down and there was an elevator suitable for TS use. However, it was seen that the dining hall's chairs and tables were not suitable for children with special needs, unlike the classrooms. In addition, it was determined that the plates, forks and spoons used for meals were not suitable for physically disabled and low vision children. It is thought that dining halls should be specially designed so that children with special needs can carry out eating activities independently [28].

It has been stated that, like all structures in kindergartens, stairs and corridors should be designed in accordance with the standards for children in terms of safety, independence and accessibility [40]. In our current study, it was seen that the stairs and corridors partially comply with the standards in terms of structural design. It was concluded that the bottom of the stairs were not covered and the design was not made to the required standards for visually impaired/low vision children. Although stairs and corridors are important to ensure accessibility for children with special needs, they must be designed in a way that does not pose a safety risk [41]. It was observed that the parent waiting area, which is located at the end of the corridors, was not designed to ensure the comfort of the parents. Waiting and rest areas for parents who accompany their children at school for long periods of time should be designed comfortably in all private education kindergartens. It was observed that the school's hygiene was at standards that would not pose a health risk to students. Since the immune systems of children with special needs are at risk of being weaker than those of typically developing children, it is of great importance to create high standards of hygiene areas in special education kindergartens [42].

It has been emphasized that doors and windows in kindergartens should be designed with protective auxiliary equipment against safety and injury risks, and that this is even more important for children with vision problems [41]. In our study, it is seen that the windows and doors of the kindergarten largely meet the standards in terms of design, structure and protective measures. However, it was determined that the windows did not have protective grill railings, which pose a serious security risk. In general, children with low vision do not have structures with increased contrast. In addition, it has been determined that some electrical sockets are uncovered and close to the ground, which poses a risk. The fire and emergency systems at the school are ergonomically designed. It is thought that windows and doors pose a serious safety risk in terms of falling, shaking hands and impact, and electrical equipment also poses a serious safety risk against electric shock. Therefore, it is thought that serious precautions should be taken regarding the safety risk in the design [20]. Having an infirmary for children with special needs is of great importance in providing rapid health care in cases accompanied by epilepsy and requiring emergency intervention. It was determined that the school had a fully equipped infirmary staffed by a nurse, but there was no health equipment in the classrooms. It is thought that having health care services at school is important for emergency intervention in symptomatic situations of children with special needs or sudden accidents and injuries [43].

It is stated that having botanical areas and a regular plant design in kindergarten garden areas is important to provide a calming and healthy air environment for children [44]. In our current study, it was seen that the school garden was quite good in terms of structure and landscape architecture. School gardens should be designed to ensure that various plants and trees are arranged in accordance with appropriate safety standards [45].

It is stated in the literature that accessible parks should be designed for all children, with and without disabilities, with slides and high-safety swing designs with ramps for the disabled [46]. In our current study, it was determined that the structure, design and safety features of the slides and swings in the playground were not suitable for children with physical disabilities. Special education school parks should be designed to be universally accessible to all children, with all their features [47].

The areas where children walk in kindergartens should have a suitable ground structure against falls. It has been stated that children with special needs may need to rest during garden activities and therefore there should be ergonomic and adaptive rest areas [48]. In our current study, the outdoor floor of the kindergarten consisted of non-slip paving stones and was planned to not pose a security risk. In outdoor design, the walking area floor must be covered with materials that will not pose a fall or safety risk [11]. Although it was important to have open and closed outdoor seating areas designed for resting and spending time in summer and winter seasons, these areas did not have suitable seating structures for children with physical disabilities. The indoor and outdoor spaces of the kindergarten should be designed so that children with special needs can also use them [49].

During the time that children in kindergarten spend in the garden environment, the safety and ergonomic quality of the architectural structure of the outdoor environment eliminates the risks such as possible falls and injuries [50]. In our study, it was determined that requirements such as the presence of a security guard at the garden gate, the structure of the garden wall, the garden infrastructure, vehicle passage areas and the parking lot being independent from pedestrian traffic, and lighting comply with the standards and are ergonomic in terms of security. It is thought that security is a serious risk factor, especially for children with mental and visual disabilities, and therefore all standards regarding security must be fully met [51, 52].

Limitation

This study has several limitations. First, the evaluation was conducted in only one special education kindergarten, which limits the generalizability of the findings to different types of institutions and regions. Second, since there is no standardized checklist specifically developed for special education kindergartens, the assessment in this study was carried out based on multiple national and international guidelines, including those published by UNICEF, the Ministry of National Education, and other relevant literature. Third, the data collection process relied solely on direct observations by the researchers. Although efforts were made to ensure inter-rater consistency, the method inherently carries a risk of subjective interpretation. Moreover, the study did not utilize quantitative measurement techniques or statistical analyses; it presents only descriptive findings. Therefore, the conclusions drawn are based on qualitative observation rather than statistical significance. Finally, although the assessment was designed to address the needs of children with physical, intellectual, visual, speech, and hearing disabilities, the single school environment included in the study may not fully represent the diversity of special education institutions or the wide range of needs among children with disabilities.

Conclusion

This study revealed that the evaluated special education kindergarten did not fully meet ergonomic standards in various aspects of its interior spaces, including classrooms, lighting, parent waiting areas, toys, toilets, the

cafeteria, and security. In contrast, heating, cooling, ventilation, and hygiene criteria were generally found to be satisfactory. With regard to the outdoor environment, garden layout, ground surfaces, and safety features were found to meet ergonomic standards, while minor deficiencies were observed in play and recreational areas. These findings highlight the need for educational environments in special education institutions to be planned in a way that meets the diverse needs of children with various disabilities. Creating accessible and ergonomically appropriate learning environments requires a multidisciplinary approach led by the Ministry of National Education and involving physiotherapists, occupational therapists, architects, engineers, teachers, school administrators, and families. It is crucial to ensure that these environments are inclusive not only for children with physical disabilities but also for those with visual, hearing, intellectual, and speech impairments. Furthermore, employing occupational therapists and physiotherapists in schools plays a vital role in eliminating ergonomic risks and enhancing accessibility in educational settings. Future studies should focus on developing and validating standardized ergonomic assessment tools tailored to the needs of all disability groups in special education settings. In parallel, large-scale studies should be conducted in which a high number of schools are systematically evaluated across different geographic regions and educational levels, in order to ensure the applicability, inclusiveness, and generalizability of ergonomic standards.

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Authors' contributions
Determining the subject and methodology of the article MC, EC, DMA, AAK; data collection MC, EC; writing MC, EC, DMA, supervision and editing AAK.

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Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was found ethically appropriate by the Lokman Hekim University Scientific Research Ethics Committee with the decision numbered 2023/190 on October 23, 2023. Ergonomic evaluation of the special education kindergarten was carried out in March 2024. The study was conducted in accordance with the Declaration of Helsinki.

For this study, written permission was obtained from the school administration (school principal) in order to evaluate the ergonomic suitability of the special education kindergarten. No evaluation was made on the participant (human) in this study.

Consent for publication
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Competing interests
The authors declare no competing interests.

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