

## ERGONOMICS FOR NEWBORNS - CERTAIN IMPLICATIONS AND RECOMMENDATIONS FOR PARENTS AND DESIGNERS

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**Abstract** This paper represents one of the first studies in the world which is related to the application of Ergonomics in meeting the needs of newborns. Ergonomic research on this subject is very rare. The main reason for this is probably that the infants are a very susceptible and delicate category of respondents. For this reason, researchers are still forced to draw many conclusions in this area on the basis of good and bad examples from practice. This paper presents possibilities and solutions that are based on the application of ergonomic knowledge in order to meet the needs of newborns. Certain ergonomic recommendations for designing rooms for babies, including lighting in the room, thermal comfort, noise, objects in the environment of newborns, as well as for baby strollers have been presented.

**Keywords:** Ergonomics; newborns; babies; room design; lighting; noise; thermal comfort; toys; baby stroller.

### 1. INTRODUCTION

To be able to understand the needs of a newborn, it is essential that we start from the basic level, ie. from feelings. The basic feeling parents have toward their child is love. However, only love is not enough to understand and meet the needs of a newborn. The love that parents feel is most often just a motivation to understand the needs of the child and the motive to fulfill these needs of the child.

Recognition and especially fulfillment of needs of newborns requires adequate knowledge. We can ask ourselves, what are the needs of newborns? We all know that the newborn needs to feel love. In addition, it must eat and drink. This need of the newborn meets instinctively by sucking breast milk. However, all the needs of the newborn do not end here. In order to be able to adequately satisfy the other needs of the child, appropriate knowledge is needed, provided by Ergonomics.



Figure 1. The needs of newborns.

In order to understand the other needs of the newborn, first of all, it is necessary that we ask ourselves, with what the newborn comes into interaction? In addition, it is necessary to know that the newborn has almost nothing in its memory and that it does not know how to think. It only has feelings, which it experiences through the senses of sight, hearing, touch, taste, smell and movement (kinesthetic sense).

## **2. ERGONOMICS OF THE ROOM FOR NEWBORNS**

Probably the first thing with which the newborn comes into interaction is the space in which it resides, i.e. a room. How does the newborn experience the space in which it resides? To understand this, it is necessary to know how the senses of the newborn function, primarily the sense of the sight, and then the sense of hearing, touch, smell and taste. In connection with this, it should be noted that newborns (who immediately after birth can distinguish only the shades of gray color) after the first week of life can recognize almost all colors, except blue [1]. The reason is that the newborn's retina does not yet contain enough receptors to recognize the blue color. Keeping this in mind, if we want a newborn to adapt quickly to a new environment, it is generally advisable to avoid using blue color in the beginning. For this reason, parents and designers should avoid that the walls in the room where the newborn should reside initially paint with blue color. The baby will habituate more quickly to the environment in which it resides if the walls are colored in tones of red, yellow, orange and green, or their combinations. White color can also be acceptable, although the baby generally shows less interest for white color. After this initial stage, blue color can be gradually introduced into the baby's environment, in order to stimulate the development of the color perception.

Although a newborn can not notice differences in contrast as an adult, it can still detect certain differences (especially when there are large contrast differences). For this reason, the walls in the room may have some patterns, which are in contrast to the color of the background. So, initially, the walls of the room can be painted in different colors except blue. Patterns on the walls (if any) need to be brighter or darker shades, compared to the primary color tone, which was used for the surface of the wall. One of the options is that the patterns of different shapes in the shades of blue (brighter or darker than the base wall color) are gradually added, for the purpose of the stimulation of the blue color perception by the newborn.

A baby cot should not be placed directly below the general light source in the room. Also, the crib should not be placed so that the natural light source directly falls on the newborn. If it is a very sunny day and there is a high level of light in the room where the baby is staying, the blinds can be used on the windows. In general, the levels of illumination recommended for neonatal units can be used in the rooms. These values range from 50 - 1000 lx during the day and 5 lx at night [2]. For the purpose of providing the conditions for easier visualization of the environment by the baby, it is desirable that the room be bright during the day when the baby is awake, which means that higher values can be selected from the recommended illumination interval. A lower level of illumination during the night is needed so as not to disturb the sleep of the baby [3]. In addition, a higher level of illumination during the night may negatively affect the hormonal biorhythm [4].



**Figure 2. An example of ergonomically designed rooms for female babies.**



**Figure 3. An example of ergonomically designed rooms for male babies.**

## **2.1. Thermal comfort and the newborn**

The feeling of thermal comfort in children does not differ greatly from the feeling of thermal comfort in adults. It is often recommended that the temperature of the baby's room be in the range of 18 - 22 °C. According to EPA, the recommended value for relative humidity is 30 - 60% [5]. Relative humidity below 60% can prevent the formation of mold, and thus allergic reactions, asthma and other respiratory complications in babies. Also, there are variations in relation to the aforementioned

recommendations, taking into account the season. Recommended values for temperature and relative humidity of the air, depending on the season, for rooms where stay the children of preschool age are [6]:

*Winter period*

Temperature 18<sup>0</sup>C-24<sup>0</sup>C, relative humidity 30-50%

*Summer period*

Temperature 20<sup>0</sup>C–28<sup>0</sup>C, relative humidity 30-50 %.

The baby should not be subjected to direct airflow (especially of higher intensity), regardless of whether the room flow is realized in a natural or artificial manner by means of air conditioning. For babies there is no official recommendation for safe air movement in closed rooms. Although the airflow rate depends on the temperature and the relative humidity of the air in terms of thermal comfort in adults, it is considered that the airflow in the summer months should not be greater than 0.9 m / s. In winter months, the airflow rate in indoor rooms should not be less than 0.15 m / s [7].

However, the care should be taken if the child was previously in the incubator. In the incubator and other devices of similar purpose, a lower value for air flow, between 0.1 m / s and 0.45 m / s [8-9], are used. In this case, it is necessary to adopt lower values for the air flow in the room where the newborn resides, i.e. harmonize them with the values used in the incubator.

If there is an air conditioner of any kind in the room where the baby needs to stay, it is mandatory to clean or replace the filter before it arrives. In this way, conditions will be created for the baby to breathe pure air, without microorganisms (spores, bacteria, viruses, fungi). All that is said about the thermal comfort of the baby in the room is also valid when the baby is in the car, which uses the air conditioner.

## **2.2. Newborn and noise**

Of course, proper attention also should be given to the design of the acoustic environment of the newborn. In the first three months of life, the baby is able to [10]:

- recognizes human speech and responds to it in the first month
- make the difference between some loudly spoken words, in the second month
- responds vocally to the speech of others, in the third month.

Although the hearing of the newborn is not equally sensitive to all parts of the sound spectrum as is the case with an adult, babies also react to noise. It is known that the hearing threshold in babies is higher than in adults. However, babies often cry when they hear the noise and turn toward the source of the high-intensity sound.

As with adults, high-intensity noise can permanently damage the hearing sense of the baby. The impulse noise can do that in a moment (eg noise of 140 dBA). However, a similar effect may also have a lower intensity sound, eg 80 - 85 dBA in longer duration, eg 8 h. For babies there are no

standards for permitted noise levels as for adults. However, it is considered that the level of noise to which the baby may be exposed should in no way to exceed 80 dBA in the duration of 8 h. However, the optimal rule for a baby is that the noise in the room in which it resides does not exceed the level prescribed by the law for staying in the residential premises. This value usually varies from country to country. This value usually varies from country to country. The most common is 40 dBA during the day and 35 dBA at night.

However, at the earliest age, noise can be useful. White noise is a noise composed of a large number of frequencies whose intensities are equal, such as, for example, the sound that comes from the murmur of a creek. The results of the research have shown that white noise can be an effective non-pharmacological method for controlling of baby's pain, reducing the time of crying and can have positive effects on the behavior of the baby [11]. For this reason, the use of white noise is recommended when performing a procedure with a baby that can be painful or unpleasant.

### **3. ERGONOMICS OF OBJECTS IN THE SURROUNDING OF A NEWBORN**

Bearing in mind the problem of newborns in relation to recognition and interest in colors, one of the important aspects is the color of the clothes that the parents carry. Bearing in mind what has been previously said for colors, in order to facilitate the identification of parents by the newborn, it is advisable that their clothing initially is not based on the use of blue color. The quick recognition of parents from a certain distance based on the color of the garment (in accordance with the principles of color coding) can contribute to its sense of calmness and well-being. To this end, in the first month after birth, it is advisable for parents to wear clothing of red, yellow, orange or green colors, primarily brighter shades, which may contain darker contrasting segments. If feasible, it is advisable to provide more pairs of identical clothing items with the mentioned characteristics, in order to enhance fast habituation and easy recognition of the parents. Later it is desirable to introduce some apparel details that are based on the application of blue color, in order to stimulate the visual system of the baby.

It is important that parents realize that the sense of vision in a baby is equally underdeveloped and reduced in functionality, as is the case with its extremities - arms and legs. As the baby cannot stand or sit, so similarly it does not see the world as it adults can. In the first month of life, the baby has major problems with visual acuity. For example, if an adult person of normal visual acuity is looking into a single object from six metres distance, this is for a baby like it is looking at the same object from the distance between 60 and 120 meters (the visual acuity of a child in the first month of life is between  $6/60$  and  $6/120$  [1]), and according to some authors, even from the distance of 192 m [12]. For this reason, if you want your baby to see you more clearly, you have to get close to her. The same goes for any object you want to show to the baby. A newborn can most clearly observe the object at a distance of 19 cm from the eye [13]. If we want the baby to see sharply a particular object, then it should be positioned in the range of 20 - 30 cm from the baby [14] (according to some authors at a distance of 20 - 50 cm from the baby [15]). Outside of this zone (closer or farther) baby to the first month of life the object see blurred. With around 2 years of age, a child achieves the visual acuity of an adult person [1].

Therefore, if it is necessary for the baby to clearly see an object (or face of the parent), it is best to position the object to the previously mentioned distance, of about 19 cm. However, the newborn does not yet have the ability to follow the movements of the object without problems. For this reason, in this earliest period, the fast movements of objects with which we want to draw the attention of the child should be avoided. In the fourth month of life, appears significantly improvement of the ability to track objects [1].

The newborn can relatively well notice the shape of an object, i.e. its contours. There are cases where the newborn was not able to recognize a mother who changed the contours of clothing and hair. For this reason, in the first months of the baby's life, parents should strive to keep the established pattern of clothing colors, but also the form of clothing that they wear.

Given that the newborn has no developed ability for catching objects by hand, it is not necessary to give him a toy in that earliest period. Instead, it is recommended to hang toys of various shapes and colors (preferably without blue color in the beginning, as shown in Figure 4) above or beside the cradle. With the gentle movement of these toys, it is possible to attract the interest of the baby, but it is also possible to further influence the development of the function of accommodation of the newborn's eyes.



**Figure 4. An example of the ergonomically designed toy adapted for newborns.**

Although there are variations, the newborns sleep a total of 14-17 hours a day [16]. Almost all day, a baby is in the interaction with the bed. For this reason, special attention should be paid to the choice of cradle and mattress. It is known that some people prefer stiffer surfaces for sleeping, while some like softer surfaces. Bearing this in mind, one of the best solutions is a mattress that has two sides (two cores), a side that is harder (eg with a hardness of about 28 kg/m<sup>3</sup>), and a side that is softer (for example, with a hardness of about 23 kg/m<sup>3</sup>). In the first days of life, it is recommended that the upper side of the mattress be harder (which is in contact with the baby), to prevent its unwanted overturning.

The solid surface of the mattress at the same time prevents the baby's face sink into the mattress and thus provides an undisturbed baby's breathing. Later it is possible to use a softer side so that the baby feels comfortable and develops the spinal column correctly. In addition, it is recommended that the cover of the mattress can be removable, as well as to be waterproof, anti-allergic and washable.

From the aspect of safety, it should be noted that in the cradle should not be placed any object that could potentially endanger the baby in any way. With about two months of age, the baby will try to reach an object in its vicinity. If the baby grasps the object, it will want to test it with her senses - above all with the sense of taste. There is practically no object that the baby will not want to put in his mouth. Since the newborn does not have previous memory, it essentially examines whether such a thing is for a meal. Even sense of smell will not stop the baby in that intention. Babies are able to even diapers to try to eat. It should be kept in mind that the child will want to taste even substances that have a strong and unpleasant smell.

#### **4. ERGONOMICS OF BABY STROLLERS**

Particular attention should be paid to the selection of baby strollers. In them, the child will spend most of the time when it is not in the cot. The question of choosing a stroller is not just connected with the comfort but also about the safety of the child. From a database of injuries of EU member states, it can be noted that, on average, 5900 children aged 0 - 4 years suffer from injuries requiring medical treatment when using the strollers [17]. It is estimated that in just one year, 14400 children under 5 years had medical intervention in hospitals in the United States due to child - related injuries with strollers [18].

There are several ways in which child injuries occur when using a stroller. The causes of injuries are not only related to the design of baby strollers but also to their use. The most common injuries are related to injuries to the head, neck (choking) and limbs. In the United States, only in the period of four years, 23 incidents with strollers were reported, which led to the fingertip amputation in children under the age of 5 [17]. In 2010, Maclaren pulled out a million strollers for babies from the market due to amputation or injuries of fingers, due to the stuck in stroller hinges. Another company, Graco Children's Products Inc. recalled about 1.5 million baby strollers [17] due to injuries sustained when opening or dismantling the canopies.



**Figure 5. Baby should not be left alone in a stroller without supervision for safety reasons.**

The most common mechanisms for injuring babies in strollers are [17,19]:

- When the baby is not under supervision, it can move by the body movements to the edge of the surface of the stroller that is intended for lying down, and then, firstly with the legs and then with the rest of the body the baby can flow through between the area that is intended for lying down and the bar that is designed for pushing the strollers, so that the head remains stuck between the two parts, which is indicated by the arrows in Figure 5. In this case, the baby can suffocate.
- The fingers of a child can be trapped in various folding mechanisms.
- The stroller can be overturned due to the weight of the load that is sometimes placed on a bar intended for pushing the stroller, or when the child attempts to stand in the stroller. In this case, head injuries are most common.

When buying a baby stroller, it is necessary to pay attention to the following basic safety aspects [17, 19]:

- It is necessary that the strollers have safety belts to keep the baby in the desired position. Newer strollers are made with a belt with five points. It is necessary to verify the strength of harnesses, as well as the possibility of their easy fastening and unfastening.
- Strollers must have brakes, whose operation should be checked during purchase.
- Make sure that the strollers cannot be folded up when the baby is inside them. There should be a safety lock device as a preventive measure.
- Make sure the part for storage (bags and the like) is located horizontally, below the part intended for the baby. Alternatively, the shopping tray can be located low, above the rear wheels, so that the balance of the strollers cannot be disturbed.

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- If using a second-hand stroller, check if there are any metal or plastic pieces that can injure the baby.
- Check the declaration on the stroller whether it meet the European safety standard EN 1888: 2012 or other equivalent standards.
- After purchase, periodically check the general condition of the stroller.

The basic recommendations for safe use of the strollers are [19]:

- Do not put bags and other things over the handle of the stroller because this can cause them to roll over.
- Use the harness every time the baby is in the stroller.
- Do not leave the baby out of control, even if it is asleep in the stroller.
- Regularly check the brake operation, especially when the stroller with full load is on a slope.
- Check the position of the legs and arms of the child before any adjustment of the stroller, in order to prevent injuries of the extremities.
- Keep the baby away from the stroller when folding or unfolding it.
- Do not allow the child to stand in the stroller.
- Do not use a pillow, a piece of clothing or a blanket like a mattress, as they can cause a newborn's choking.

In addition to safety features, the baby stroller should possess certain comfort-related features. Recommendations for choosing comfortable strollers are:

- Advantage should be given to the stroller with a flat surface where the baby can stay (sleep). It is desirable that part of the surface can be erected and turned into a backrest, which allows sitting position of the child.
- The advantage should be given to the strollers where the grip can be moved forward and backward, so that the baby can look at the face of the parents as necessary or orient in the opposite direction.
- It is desirable that the grip be adjustable in height so as not to bend the torso when pushing the stroller (or to achieve any other improper body position).
- Choose a stroller with a canopy that protects the baby from sun, rain, and other weather conditions.
- Choose a stroller that has a footrest because the child will usually use it during growing up.
- Consider the possibility of purchasing a luxuriously equipped ergonomic stroller with automatic drive, with ventilation in the backrest, whose basic part can be used as a baby seat in the car, with the additional function of the rocking chair, with the accessory that allow that the stroller can be attached to the shopping cart, with the LED light, etc.

## 5. CONCLUSION

This paper is the first article in the world which contains words Ergonomics and newborns in the title. This fact indicates that ergonomic studies on this topic are very rare. However, this study has shown that Ergonomics plays a crucial role in meeting the different (other) needs of the newborns. In most cases, only the application of ergonomic knowledge can ensure the safety and comfort of the child, which will contribute to its happier and careless growing up. The ergonomic recommendations presented in this paper can be useful to parents, who face new challenges for the first time, such as setting up an environment for the newborn. Their application will reduce the certain problems of parents in raising the child, for which they probably would not know the cause. Additionally, the

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recommendations presented can also be useful for interior and environmental designers for newborns, as well as for toy and baby strollers designers.

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