The Minimum Area Required for Children Aged Between 3 and 5 Years Old in a Kindergarten

Julie Waldron [ab], Ader Garcia [b], Carolina Bedoya [b], Lady Cuervo [b], Laura Marin [b] and Catalina Morales[b]

[a] Programa Buen Comienzo
Alcaldía de Medellín
Medellín, Calle 49 N° 50-21, Colombia

[b] Energy, Environment and Technology Group - EMAT
Universidad Nacional de Colombia
Medellín, Calle 59A 63 – 20, Colombia

ABSTRACT

This paper contains the first stage of a research developed by *Buen Comienzo Programme*, Medellin Mayor's Office and a group of Architects, to identify the minimum area required for a child aged between 3 and 5 years old, while occupying a kindergarten. According to the Colombian Technical Regulation (NTC4595) for architectural design in Colombia, the minimum area for Educational Buildings is 2 m^2 per child. This measure includes: the work area (0,5 m x 0,7 m =0,35 m^2) per student, the storage area (10% of the work area, 0,035 m^2), and the area for general furniture. Pursuant to this standard, it can be deducted that occupancy of buildings is determined by the regular furniture dimensions. However, the movements of children are determined not only by furniture but also by their relationship with other children. Therefore, data of children's dimensions in movement can improve the decision making process for the architectural design, pedagogy and the review of regulations. This research was developed considering that a child spends 70% of their time in a kindergarten, in constant interaction with other children, objects and furniture. The content will refer to the review of world and local regulation about children occupancy in educational buildings.

Keywords: Minimum Area, Children, Kindergarten, Technical Regulation.

INTRODUCTION

By 2010, Medellin, Colombia had a total population of 2'343,049 inhabitants, of which 205,652 were under the age of 6 years. 71% of them, were children under 5 years and living in conditions of vulnerability (Herrera R, 2012). Nowadays public policies are making an effort to improve their coverage in order to give these children an integral care. Given the lack of proper infrastructure to educate and care for this population of children, between 2008 and 2010, under the public police of integral care to the early childhood, approved by the city council, the task of building 15 new kindergartens, located in the most vulnerable neighbourhoods of the city began. The aim of this public investment was to ensure an improvement in the area of nutrition and educational care for the young population living in these communities. An amount of COP$ 356,097 million of Colombian Pesos, approximately equivalent to US $176,460,000, were invested in this project.

In order to build the educational infrastructure, to estimate the investment required and to extend the coverage capacity of the Municipality's early childhood programmes, it was necessary to know the area occupied by a child in each of the spaces of the kindergarten. The technical standards available at the time, suggested an area per child between 1 m^2 and 2 m^2 (Departamento administrativo de Bienestar Social del Distrito Capital, 2006; Presidencia de la República, Fundación éxito, & AEIOTú, 2011; Programa Buen Comienzo & SEN, 2012). In the absence of more

specific information about Medellin's children population, this research was developed with the purpose of identifying the area that a child between 3 and 5 years of age uses during kindergarten activities, and its similarities to the consulted standards.

In the international standards reviewed, could be identified the area in square meters assigned for a child in a classroom. In countries like the United States, Canada and Australia, the guidelines and standards indicated a greater amount of area per child within classrooms, between 3,30 and 5,97 m^2 per child (City Council - city of Vancouver, 1993; Department of Education and Early Childhood Development, 2007; GSA, 2003).

On the other hand, in Latin-American countries the area required for classroom, varied between 1,0 m^2 and 2,0 m^2 per child and in recreational areas the value increases to 3 m^2. The restrooms and Cafeterias appear as differentiated spaces and complementary areas to the educational activity developed in the classrooms (Programa Buen Comienzo & SEN, 2012; Presidencia de la República, Fundación éxito, & AEIOTú, 2011; Departamento Administrativo de Planeación. Alcaldía de Medellín, 2007; MEN Colombia, 2006; Oficina Internacional de Educación de la UNESCO (OIE), 2006; Ministerio de Educación Nacional Chile, 1988). In the absence of information for the population of Medellin, this project was developed in order to identify the amount of area a child, between the ages of 3 and 5 years, uses while they are in a kindergarten, and to compare these values with the ones consulted in the standards.

For this study, the anthropometric measurements of preschool Mexican children, between the ages of 4 and 5 years, were taken as a reference (Ávila, Prado, & González M, 2001), in the absence of an anthropometric data validated for Colombian children between the studied ages. According to the observation of these data, 6 healthy children of both genre, with normal growth characteristic and part of a school day routine determined by *Buen Comienzo Programme* were chosen as a representative sample. Based on the anthropometric classification validated by a specialist in ergonomics and anthropometry, the body dimensions chosen to determine the percentile of the sample, were height and weight as recommended by Panero & Zelnik (1996). After selecting the sample, the body gestures of the children were photographed and recorded in different planes, then digitalized and compared to each other, so at the end, the child occupancy area while executing a school day activity routine could be determined.

The purpose of this paper is to present the local and international regulatory context, of the documents that determine in square meters per student the "Minimum Occupancy Area" for educational buildings used by children between 3 to 5 years of age. Additionally, a study performed for *Buen Comienzo Programme* will be presented. The aim of this study was to determine the variability in the area of occupancy, according to the following parameters: percentile, postures, and the activities performed by children of 3-5 years of age.

OCCUPANCY AREAS IN EDUCATIONAL BUILDINGS FOR CHILDREN FROM 3 TO 5 YEARS OLD

The reflection about areas of occupancy by children in kindergarten classrooms represents a significant step forward to determine the minimum area actually used for them in educational buildings; though it is important to say that this is also determined by the specific academic characteristics of each institution (Toranzo, 2007).

Children crawl, kneel, stand, climb and jump spontaneously and they do it without pauses between positions (Monteys & Fuentes, 2007). It seems obvious that children space occupancy counted in square meters, does not express all the possibilities in which this space can be used. The occupancy varies substantially depending on the spaces used, the activities developed, and body postures assumed. The time on which a space is fully occupied also varies depending on the age group under study. In addition, the minimum area required for these activities cannot be counted only as the physical area actually used. There are also complementary areas that allow the human being to transit and change position to perform an activity in which it is possible to share spaces comfortably with others without obstructing their movements and transit.

However, it is common to see how occupancy is thought as a bi-dimensional measure from above or in a plan view. Occupancy is measured trough surface units and by determining a number of objects that fits in there. The Cartesian plane approach of occupancy shows little data regarding how children use space around them. Furthermore, to contain children space experiences in the axis '*x*', '*y*' and '*z*', is to underestimate their conditions and characteristics.

According to this, it is clear that children occupancy con not be measured in square meters, and that their space cannot be limited to standards established without considering their special conditions. However, this research was made taking into account the square meters measures to compare them with the occupancy technical data established in several legislations national and internationally.

To have in mind the size, corporal dimension of children and their manners to interact with objects, offers valuable information for architects, industrial designers, and teachers, about space and its relation with the Human Body and the attitude of its postures in the classroom. In addition, it is important for the authorities in charge of defining the planning of the cities, to know the minimum dimensions required in the first years of children, so they can establish the coverage of education according with the installed capacity of educational buildings and the necessary budget for the future.

Review of the local legal context

The regulation available in Colombia to determine the minimum area required per child, has varied substantially during the past 5 years. The information available shows the lack of clarity regarding the minimum space occupied by children from 3 to 5 years old. Below, there is a list of the regulation available:

1. *Colombian Technical Regulation - NTC 4595* of planning and design of educational environments. On his chapter 4 named Basic Pedagogic Environments, says that the area (square meters per student) must be of 2 m^2 composed by: calculated work area 0,5 m x 0,7 m (0,35 m^2), storage area of 10% of the work area (0,035 m^2) and area for computer, board and tutor's desk (MEN Colombia, 2006).

2. "*De Cero a Siempre*" is the government national strategy for the complete attention of children in his early years. In the appendix of the evaluation report of children complete attention, can be found a document called *Complete Development of children in his early years*, where in his chapter 5 standard 55, says: the minimum area per child in a building built from 2011 to the date is 2,0 m^2 and for buildings built before 2011 the minimum is 1,5 m^2, with the obligation to perform the necessary adaptation to comply with the 2,0 m^2 standard. (Presidencia de la República et al., 2011).

3. The Resolution 501 of 2012 from the Medellin's Municipality which includes the regulations and standard of the service for the complete attention of children in his early years for the *Buen Comienzo Programme*. In the chapter 2 called life and survival subcategory -infrastructure, spaces for attention, it is stated that: the minimum area per child attended must be of 1,5 m^2 (Programa Buen Comienzo & SEN, 2012).

4. The decree 243 of 2006 from the Bogotá's mayor office, states in his article 17 regarding infrastructure, as follows: for the building of kindergartens, the institutions must have 2 m^2 per child attended (Alcaldía Mayor de Bogotá, 2006).

5. In the Resolution 1001 of 2006 from the administrative department of the common wealth, its article 33 states as follows: the area in classrooms for children from 2 to 6 years old must be at least of 1 m^2 with the goal to increase it to 2 m^2 per child. (Departamento administrativo de Bienestar Social del Distrito Capital, 2006).

6. In the Technical Quality Standards for the initial education services from Bogotá's Mayor office, says as follows: the minimum area per child attended must be of 1 m^2 (Alcaldia Mayor de Bogotá, 2009) .

7. In the guide of infrastructure execution - kindergartens for the attention of children at early years, from the Colombian Institute for the Family well-being (ICBF), says that: the minimum area per child is 2 m^2 for a maximum of 30 children per classroom. (MEN – ICBF CONPES SOCIAL 115, 2007)

According to the review performed to the current regulation for the building of kindergartens in Colombia, it is possible to observe that there is not a minimum occupancy area identified for children from 3 to 5 years old. This research seeks to establish one parameter that integrates all the concepts, based on studies in real population.

Similarly, it can be concluded that coverage of the service for the attention of children in his early years can vary up to twice its capacity, since there is an inverse relation between this and minimum area threshold. This means that higher the minimum area is set, fewer the children that can be attended in the educational system through the public kindergarten in Colombia.. Based on this, studies of "Minimum Areas" seek a greater capacity of care in school buildings without compromising the quality of the habitability of the spaces.

Review of the international legal context

Regarding the international legal context, the conditions are similar. There are significant differences between the regulations about “minimum occupancy areas” per child, as different parameters were taken in consideration for every one of them.

Below, there is a list of the regulation available:

1. *The Child Care Center Design Guide. Public Buildings Service Office of Child Care*, developed by the GSA- General Service Administration of the United States. In its Chapter 5 of Space Planning and Location, determines the minimum parameters for Classrooms: 4,4 m² per child for groups composed by 20 preschoolers or less, not counting support areas within the painting area, washing hands / face and restroom per child (GSA, 2003).

2. *In the Childcare Design Guidelines- Land use development policies and guidelines.* Document developed by the City Counsel of Vancouver Canada. In the Chapter regarding Net Areas Recommendations states an area of 3,12 m^2 for children between 2 and 5 years of age attending half school day during the morning or afternoon (2-3 hours daily) in groups up to 25 children, and 5,12 m^2 per child for those who attend full school day (City Council - city of Vancouver, 1993)

3. The *Design guide for Victorian children’s services.* Document developed by the Department of Early childhood Education of the city of Victoria in Australia. In its Chapter of Internal Spaces as a service for children, makes reference to the *Children’s Services Regulations of 1998*, where in its article 42 states that for children younger and older than 3 years old, the area should be 3,3 m² in the Classroom excluding the area occupied by fixed furniture (Department of Education and Early Childhood Development, 2007).

4. The document *Basic Criteria and Standards for School Buildings* presented by the Argentinean National Department of Education and in charge of the Department of Infrastructure, in its Chapter 3, section 3.2.3 classification of basic locals, states: for initial and kindergarten level it must be guaranteed a minimum area of 1,60 m² per child and it is intended that this rate reaches 1,80 m² per child as recommended value in groups up to 28 children. The value given per child do not include storage area (Ministerio de Educación Nacional Argentino. Presidencia de la Nación. Dirección de Infraestructura, 2003).

5. *The Despacjo Conjunto no.* 268/97, of the Ministry of Social Education and the Ministry of Security and solidarity of Brazil, defines the Pedagogical and technical requirements for the installation and operation of pre-school education establishments in its Annex number 1. About the classrooms it states that 2 m^2 per child are required in groups up to 25 children per class (Ministerio da Educação, Social, & Segurança, 1997).

With the review of international standards to determine the "Minimum occupation Area" in Kindergarten, it can be observed that there is no comparable indicator across countries, regarding the minimum value of square meters per child required for preschool spaces. The values recommended in the United States, Canada and Australia exceed the local regulation values and some of Latin American countries recommendations by almost 1 m^2 per child.

The studied documents do not specify if the value given per child took into consideration the area occupied by the furniture or corridors. The Argentinian document offers much lower values than those given by the other countries; however, it excludes the storage area. This suggests that other indicators do include furniture or other complementary areas.

The parameters used to establish the value of the square meters per child needed are not similar in any of the studied documents. The age classification between 3 to 5 years of age, presents the need of more space per child or occupancy area and therefore, fewer children within a classroom. This allows children to develop feeding and recreation activities, without affecting its habitability.

In the different standards, statutes, resolutions and other documents referred to quality in buildings for early childhood attention, is visible the difference in the understanding of the concept "Minimum Occupancy Area" per child. In the local context the lack of technical basis for defining this occupancy rate, is evident. Therefore, starting from the current legal situation and the Anthropometrical and Architectonical studies developed; below it is presented some of the methods and results of the investigation conducted about the minimum occupancy area required by children between 3 and 5 years of age, for kindergartens located in the city of Medellin.

METHODOLOGY

To evaluate the "Minimum Area" of occupation needed by children aged between 3 and 5 years, when they take commonly used body postures for daily activities in Kindergartens, it was necessary to observe their daily routine and differentiate the positions adopted. For these reasons, this study was developed in 3 stages. Stage 1 was a field test where 6 children, 3 of age 3 and 3 of age 5, were photographed assuming body postures, commonly used within a Kindergarten. During Stage 2, the photographs taken in the previous stage were analyzed, vectorially digitalizing the body of each of the children making different postures in Computer Assisted Drawing software – CAD. Finally, using the analysis of the previous stage and the obtained digital images, the outlines of the three children of the same age assuming each position were overlaid, and a total area of bodily gesture was generated.

Stage 1: Field Test

After observing the academic routine in some kindergartens in Medellín, various postures adopted by children were identified. Just like Edward T Hall (1966) stated that human body has "hidden dimensions" and interacts in four proximity zones: intimate, personal, social and public distances, this study identified that children are behaving also in specific zones. These zones determine the relationship of the child with the environment and the minimum space required for each activity.

In the classroom were identified three zones: *Intimate, Familiar and Social*. The last one corresponds to the zone where the child develops social relationships with different persons (known and unknown). The Familiar zone refers to the area where the child can establish relationships with known people and is looking to be part of groups. Finally, the Intimate zone is the space where the kid is interacting with himself or a particular object.

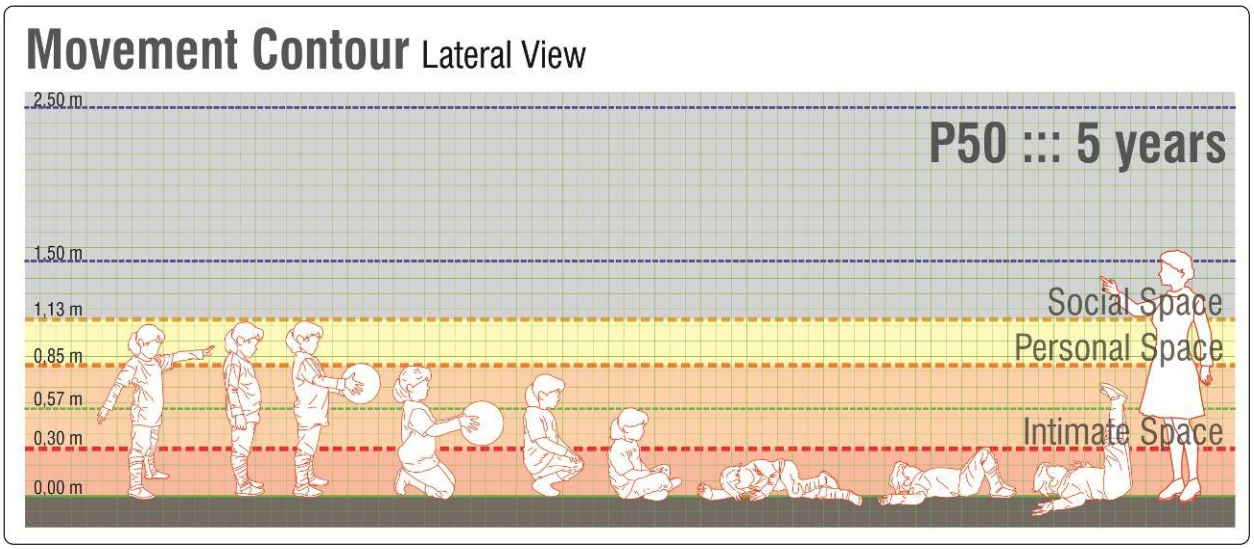

Figure 1. Movement Contour

According to the Figure 1, the activities are performed on these 3 areas. Most of the Social space activities required the child to be standing. The Personal space is composed of middle positions, such as sitting or kneeling; and the Intimate space is integrated by activities in which the child is lying. In this way to perform this study 3 basic gestures were selected: *Standing, Sitting and Lying down*, postures that correspond to the three areas or dimensions that were observed.

Once the basic corporal gestures were defined, there were identified three positions for every one of them (Fig. 2). For the *Stand up* gesture, there were selected the straight position (standing, legs together, arms extended to the sides), Spider (Standing with a leg in the front and the other behind, and both arms extended to the sides) and to Receive/Deliver (legs together, upper limbs extended to the front holding an object). For *Sitting*, there were selected the lotus position (sitting, crossed legs and arms over the legs), Squatting (legs bended in the front, without sitting) and Kneel (kneeling, upper limbs extended to the front holding an object). Finally, for *Laying down* postures there were selected the Fetal position, Laying on the Back (legs up 90°) and Laying on the Back (legs up 45°).

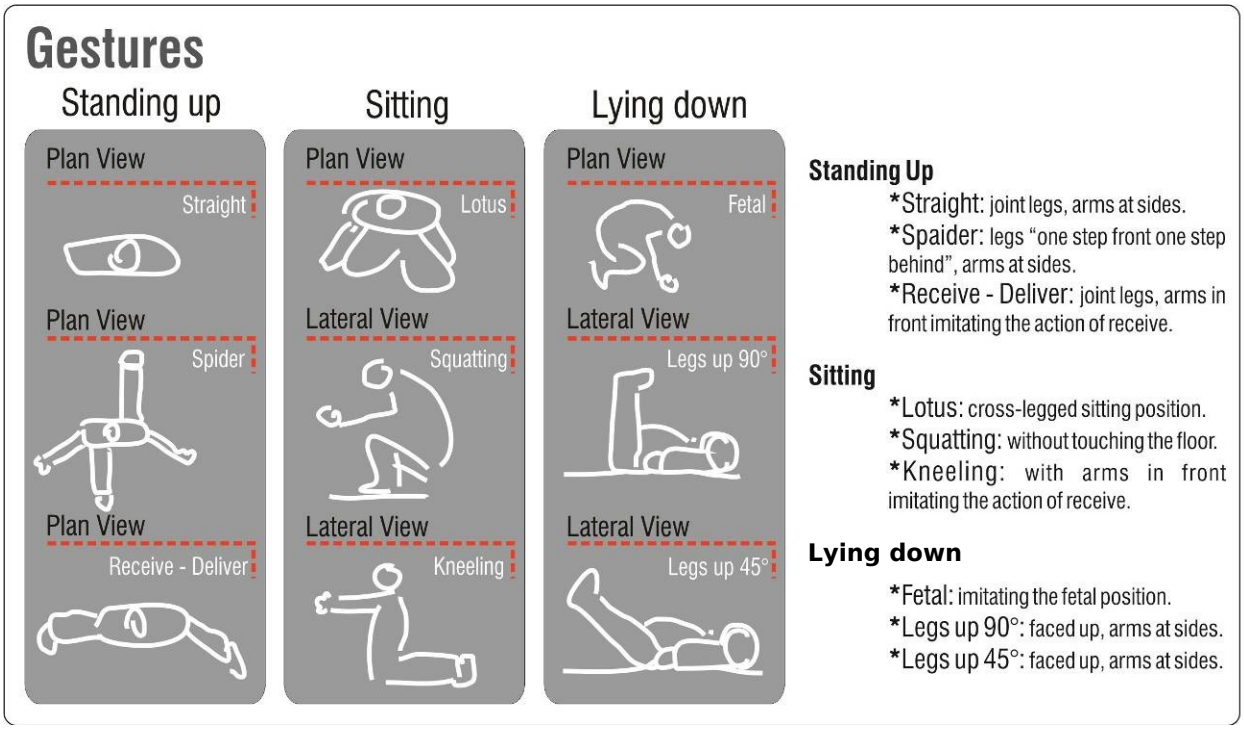

Figure 2. Gestures and positions selected

For the data collection process there was decided to take a sample of six models: two kids and one girl of 3 years old and two kids and one girl of 5 years old. The models were selected to have a 5, 50 and 95 percentile for every age. The percentile chosen as a selection parameter was height. Since Colombia does not have an anthropometrical data base for the studied population, the data taken as reference were obtained from "Anthropometric measures, Preschool 4-5 years", which contains the anthropometrical data base of children in México of the above mentioned ages (Ávila et al., 2001).

This sample was taken from the group of children who were participating at that moment in the activities of *Aures Kindergarten* in Medellín, for the *Buen Comienzo Programme*. This selection was made by a specialist in ergonomics and anthropometry.

Once the models and postures were selected, the positions of every posture were photographed through a standard procedure of image capturing, from three points: Frontal view, lateral view and plan view. 172 pictures were taken, 27 for each of the models.

Stage 2: Image Processing

Every image obtained at the previous stage, were digitalized delineating the silhouette of the children through sketch software – CAD, in this case AutoCad[1]. There was a special care on detailing the silhouette of the head, torso and limbs, to determine the total area that model´s body occupies in every position and point of view.

This visual and numeric information is then organized in data sheets, where the positions in the three points of view were visible over a 0,1 m x 0,1 m grid (Fig. 3) which allowed calculating the occupancy area.

[1] http://www.autodesk.es/products/autodesk-autocad/overview

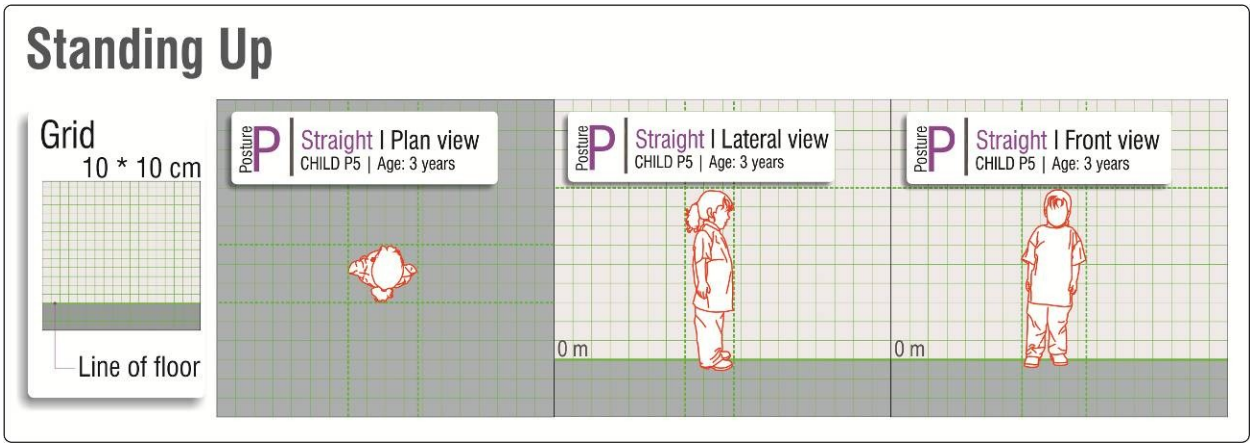

Figure 3. Example of data sheet elaborated for every posture and position.

Stage 3: Motion trace and Motion Profile

Once the images were digitalized, the silhouettes for the 3 percentiles and points of view were overlapped. This proceeding was made for the two studied ages. The overlapped silhouettes were then traced by its contour including the spaces between limbs and torso because even when these areas do not belong to the body, they are part of the posture. The resulting area of joining the contour of 3 children of the same age of different percentiles in the same posture was called *Contour* (Fig. 4).

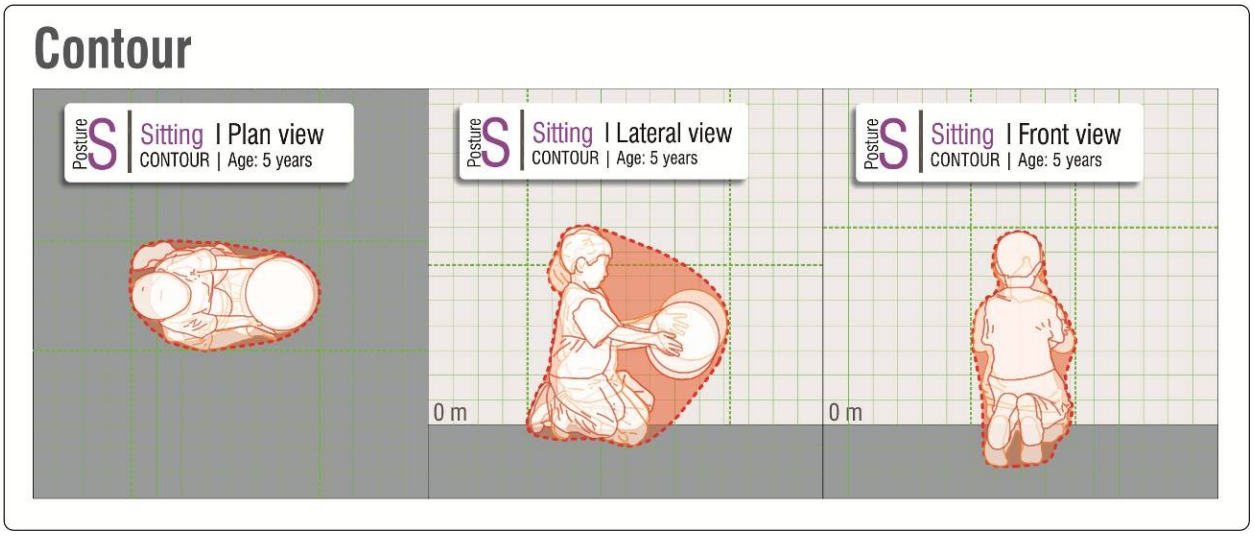

Figure 4. Contour data sheet

In a second exercise, there was made a *movement profile*, integrating all the postures evaluated in the frontal and lateral views (Fig. 5). The overlapping of these postures indicates the necessary area to move from one position to another. The contour area resulting from unifying the movement profile was called the *movement trace*.

RESULTS AND DISCUSSION

Below it can be found two analyses of the results. The first one shows the areas taken from the plan view, which represents the occupancy area in a classroom. The second one shows the front and lateral view results, height, reach and the relationship with the classroom's objects.

Table 1 shows the areas (m^2) obtained per percentile, for the positions: *Standing, Sitting and Laying down*. Table 2 shows the square meters average for each position.

Table 1. Calculation of the range of area by position. a) standing up b) sitting c) lying down

Standard Deviation by Position

Standing Up

Gesture	View	3 years						5 years					
		P5	P50	P95	DE	Mean	Contour	P5	P50	P95	DE	Mean	Contour
Straight	Plan	0,06	0,06	0,07	0,01	0,06	0,09	0,05	0,07	0,05	0,01	0,06	0,08
	Lateral	0,16	0,18	0,20	0,02	0,18	0,31	0,19	0,19	0,19	0,00	0,19	0,29
	Frontal	0,19	0,22	0,24	0,03	0,22	0,36	0,24	0,25	0,29	0,03	0,26	0,36
Spaider	Plan	0,15	0,17	0,16	0,01	0,16	0,59	0,14	0,19	0,18	0,03	0,17	0,58
	Lateral	0,18	0,20	0,22	0,02	0,20	0,42	0,23	0,24	0,25	0,01	0,24	0,53
	Frontal	0,19	0,22	0,22	0,02	0,21	0,45	0,25	0,24	0,23	0,01	0,24	0,61
Receive Deliver	Plan	0,12	0,15	0,14	0,02	0,14	0,17	0,14	0,16	0,18	0,02	0,16	0,20
	Lateral	0,21	0,23	0,24	0,02	0,23	0,37	0,24	0,26	0,28	0,02	0,26	0,50
	Frontal	0,21	0,20	0,22	0,01	0,21	0,29	0,24	0,24	0,24	0,00	0,24	0,32

* The data is given in square meters.

Standard Deviation by Position

Sitting

Gesture	View	3 years						5 years					
		P5	P50	P95	DE	Mean	Contour	P5	P50	P95	DE	Mean	Contour
Lotus	Plan	0,12	0,14	0,16	0,02	0,14	0,21	0,15	0,17	0,22	0,04	0,18	0,26
	Lateral	0,00	0,15	0,15	0,00	0,15	0,19	0,14	0,16	0,00	0,01	0,15	0,19
	Frontal	0,16	0,19	0,20	0,02	0,18	0,27	0,18	0,21	0,24	0,03	0,21	0,29
Squatting	Plan	0,11	0,12	0,11	0,01	0,11	0,15	0,09	0,12	0,14	0,02	0,11	0,19
	Lateral	0,15	0,00	0,17	0,01	0,16	0,25	0,14	0,18	0,00	0,03	0,16	0,22
	Frontal	0,17	0,16	0,18	0,01	0,17	0,25	0,16	0,20	0,23	0,04	0,20	0,27
Kneeling	Plan	0,16	0,18	0,17	0,01	0,17	0,28	0,21	0,22	0,22	0,01	0,21	0,00
	Lateral	0,22	0,25	0,26	0,02	0,24	0,51	0,27	0,28	0,28	0,01	0,28	0,51
	Frontal	0,00	0,24	0,27	0,02	0,25	0,36	0,21	0,25	0,00	0,03	0,23	0,29

* The data is given in square meters.

Standard Deviation by Position

Lying Down

Gesture	View	3 years						5 years					
		P5	P50	P95	DE	Mean	Contour	P5	P50	P95	DE	Mean	Contour
Fetal	Plan	0,18	0,25	0,23	0,04	0,22	0,37	0,18	0,21	0,27	0,05	0,22	0,41
	Lateral	0,16	0,20	0,17	0,02	0,18	0,30	0,16	0,16	0,21	0,03	0,18	0,33
	Frontal		0,15	0,11	0,03	0,13		0,10				0,10	
Legs up 90°	Plan	0,19	0,15	0,22	0,04	0,19	0,31	0,17	0,22	0,24	0,04	0,21	0,37
	Lateral	0,15	0,19	0,21	0,03	0,18	0,36	0,21	0,21	0,20	0,01	0,21	0,38
	Frontal	0,00	0,00	0,00	0,00	0,00		0,17	0,20	0,17	0,02	0,18	
Legs Up 45°	Plan	0,23	0,20	0,21	0,02	0,21	0,31	0,19	0,25	0,26	0,04	0,23	0,36
	Lateral	0,16	0,17	0,18	0,01	0,17	0,23	0,16	0,17	0,20	0,02	0,18	0,28
	Frontal	0,00	0,00	0,00	0,00	0,00		0,11	0,11	0,10	0,01	0,11	

* The data is given in square meters.

Table 2. Calculation of the Range Area by position

Standard Deviation by Position

Standing Up

Straight			
View	Plan	Lateral	Frontal
3 years	0,06	0,18	0,22
5 years	0,06	0,19	0,26
Difference	0,00	0,01	0,04

Spaider			
View	Plan	Lateral	Frontal
3 years	0,16	0,20	0,21
5 years	0,17	0,24	0,24
Difference	0,01	0,04	0,03

Receive - Deliver			
View	Plan	Lateral	Frontal
3 years	0,14	0,23	0,21
5 years	0,16	0,26	0,24
Difference	0,02	0,03	0,03

Sitting

Lotus			
View	Plan	Lateral	Frontal
3 years	0,14	0,15	0,18
5 years	0,18	0,15	0,21
Difference	0,04	0,00	0,03

Squatting			
View	Plan	Lateral	Frontal
3 years	0,11	0,16	0,17
5 years	0,11	0,16	0,20
Difference	0,00	0,00	0,03

Kneeling			
View	Plan	Lateral	Frontal
3 years	0,17	0,24	0,25
5 years	0,21	0,28	0,23
Difference	0,04	0,04	0,02

Lying Down

Fetal			
View	Plan	Lateral	Frontal
3 years	0,22	0,18	0,11
5 years	0,22	0,18	0,12
Difference	0,00	0,00	0,01

Legs Up 90°			
View	Plan	Lateral	Frontal
3 years	0,19	0,18	0,00
5 years	0,21	0,21	0,00
Difference	0,02	0,03	0,00

Legs Up 45°			
View	Plan	Lateral	Frontal
3 years	0,21	0,17	0,00
5 years	0,23	0,18	0,00
Difference	0,02	0,01	0,00

* The data is the mean by position and gesture of P5, P50 and P95, and it is given in square meters.

Analysis 1: Plan View Areas

In the case of three year old children, it was observed that positions with more area occupancy are those who correspond to the gesture *Laying down*, with an average area of 0,33 m^2. In this posture, the differences between percentiles are more distinguishable with a highest standard deviation that had a value of 0,04. For the other postures, the occupancy area is almost the same in all the percentiles.

In addition, the highest used area was obtained for the standing-spider position with 0,59 m^2. However, it is important to say that this posture is less common than those performed on the floor.

Analysis 2: Frontal and Lateral View

From the three gestures studied (laying down, sitting and standing), it can be concluded that in most of the views, the tallest 3 year old child (P95) presents very similar results to the average 5 year old child (P50). Therefore, the measures of this last percentile could be used for the calculation of the area of a 3 to 5 year old child, in a classroom.

Figures 5 and 6 show the *movement trace* resulting from the overlapping of all the body gestures studied in the frontal and lateral view. It can also be observed the total area needed for model P50 of 5 years old, to perform all the studied gestures.

In addition, it can be observed that the occupied area by the *movement trace* is considerably higher from the lateral point of view than in the frontal point of view. In the frontal point of view, the change of laying to standing gesture shows a maximum distance of 0,65 m, while from the lateral view the distance is 1,20 m for the same change of positions.

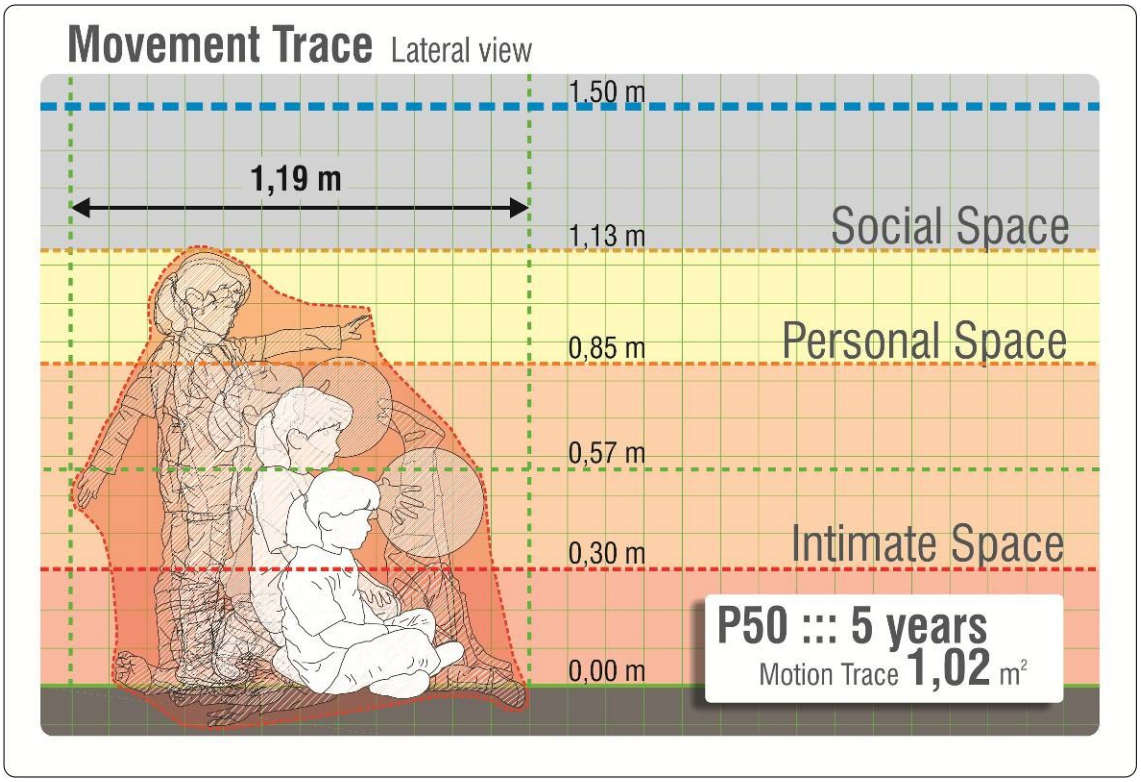

Figure 5. Movement Trace - lateral view

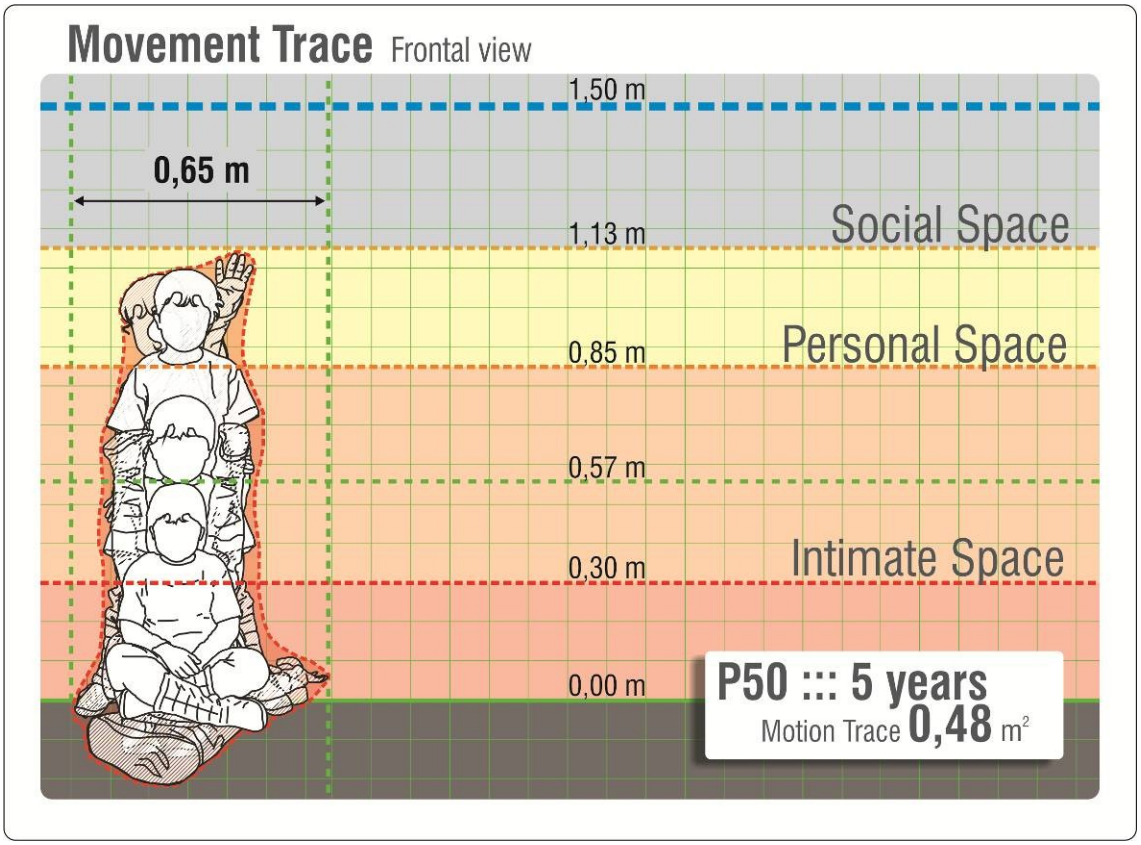

Figure 6. Movement Trace - Frontal view

CONCLUSIONS

This study shows in a plan view, the areas occupied by a child performing different postures in a classroom. However, it is necessary to clarify that the area calculation must take into account not only the physical area occupied by the human body and the adjacent area to the body needed for changing the position, but also, the interaction with objects and furniture existent in that space. Beside this, it must take into account the needed space for corridors and other requirements that may be demanded by the activity to perform.

To answer the question asked in this study, it is necessary to perform further researches taking into account the recommendations here presented.

Finally, according to local and international rates of minimum area per child in educational institutions, there are significant differences between “minimum occupancy area” in the regulations of every country and city reviewed. Therefore, it is highly recommended for local regulations to define their own parameters, including the following aspects:

- The weather, because it determine the possibility to perform outdoor and indoor activities.

- Anthropometric dimensions of the studied population.

- The pedagogy, as it determines the types of furniture used and the characteristics of the activities to perform in the spaces.

- Basic furniture of the classrooms, dining rooms and toilets must be included in the minimum occupancy area of a child.

- Socio-cultural context, being this the more abstract parameter to include in the square meters measure of the minimum occupancy area of a child. It is important to identify that the range of movement of children, their behaviour, schedule, learning methodologies, diet, among others, constitutes an important part of the body and therefore, affects the area occupied. So it is established as a topic for future researches the relationship between human behaviour and “minimum occupancy area” required by the body.

The methodology applied in this study is suitable for researches in any kind of spaces or age group, where one of the purposes is to establish the minimum dimensions required by the human body to maximize the efficiency of the use of buildings.

ACKNOWLEDGEMENT

The research team would like to thank the active participation of the school board, the Teachers, Parents and Students of the Kindergarten “Aures”, part of the Buen Comienzo Programme.

To the Anthropologist Jesus Antonio Camacho, who performed the anthropometric measurements, and supervised the choice of models and the data collection process.

To PVG Arquitectos SAS, whose team participated in the discussions panels, methodology design and data analysis.

To the Architects: Andrés Felipe Sierra and Carlos Andrés Sánchez for their supervision and guidance during the development of this research.

REFERENCES

Alcaldia Mayor de Bogotá. (2009). Lineamientos y Estándares Técnicos de Calidad para los Servicios de Educación Inicial en Bogotá. Bogotá, Colombia: Secretaria Distrital de Integración Social.

Ávila, R. C., Prado, L. R., & González M, E. L. (2001). Medidas antropométricas Preescolar 4 y 5 años. (U. de Guadalajara, Ed.) *Dimensiones antropométricas de la población latinoamericana*. Guadalajara: Centro Universitario de Arte, Arquitectura y Diseño, División de Tecnología y Procesos, Departamento de Producción y Desarrollo, Centro de Investigaciones en Ergonomía.

City Council - city of Vancouver. (1993). Childcare Design Guidelines- Land use development policies

and guidelines. Vancouver, Canadá. Retrieved from planning@city.vancouver.bc.ca

Departamento administrativo de Bienestar Social del Distrito Capital. (2006). Resolución 1001 de 2006. Bogotá, Colombia: Registro Distrital 3628 de octubre 06 de 2006.

Departamento Administrativo de Planeación. Alcaldía de Medellín. (2007). Decreto 409 de 2007. Normas específicas para las actuaciones y procesos de urbanización, parcelación y construcción. Capítulo XXI : Guarderías. Medellín, Colombia: Departamento Administrativo de Planeación. Retrieved from http://www.medellin.gov.co/

Department of Education and Early Childhood Development. (2007). Design guide for Victorian children's services. Victoria, Australia: Office for Children, Victorian Government Department of Human Services, Melbourne, Victoria, Australia. Retrieved from www.dhs.vic.gov.au/csguidelines

GSA, G. S. A. (2003). Child Care Center Design Guide. Public Buildings Service Office of Child Care. New York City, New York: Office Of Child Care. Retrieved from http://www.gsa.gov

Hall, E. . (1966). *The Hidden Dimension*. Garden city, New York: Doubleday and Company Inc.

Herrera R, M. L. (2012). DOCUMENTO DE TRABAJO INTERNO TEMA: POLÍTICAS Y PROGRAMAS DE ATENCIÓN INTENGRAL A LA PRIMERA INFANCIA – LA EXPERIENCIA DE MEDELLÍN Y EL PROGRAMA BUEN COMIENZO. Medellín, Colombia: Proantioquia.

MEN – ICBF CONPES SOCIAL 115. (2007). Lineamientos para la construcción de infraestructuras adecuadas para la prestación del servicio de atención a la primera infancia. Hogares Agrupados. Bogotá, Colombia: MEN. Retrieved from http://www.mineducacion.gov.co/

MEN Colombia Norma Técnica Colombiana NTC 4595 Ingeniería Civil y Arquitectura. Planeamiento y Diseño de Instalaciones y Ambientes Escolares (2006). Retrieved from www.mineducacion.gov.co

Ministerio da Educação, Social, & Segurança, M. de S. e. (1997). Despacho Conjunto n.º 268/97. Requisitos pedagógicos e técnicos para a instalação e funcionamento de estabelecimentos de educação pré-escolar. Brasilia.

Ministerio de Educación Nacional Argentino. Presidencia de la Nación. Dirección de Infraestructura. (2003). Criterios y Normativas Básicas de Arquitectura escolar. *Capítulo 3*. Retrieved from www.me.gov.ar/infra/normativa/normativa/index_normativa.htm

Ministério de Educación Nacional Chile. (1988). Decreto de Educación No. 548/1988. Santiago de Chile, Chile.

Monteys, X., & Fuentes, P. (2007). Los Niños y la Casa. *Casa Collage. Un ensayo sobre la arquitectura de la casa* (pp. 1–144(Pág 36)). Barcelona: Editorial Gustavo Gili-GG.

Oficina Internacional de Educación de la UNESCO (OIE). (2006). Argentina: Programas de atención y educación de la primera infancia (AEPI). Ginebra, Suiza. Retrieved from efareport@unesco.org

Panero, J., & Zelnik, M. (1996). *Las Dimensiones Humanas en los Espacio Interiores. Estándares antropométricos*. (E. G. Gili, S.A. de C.V., Ed.) (Séptima., pp. 1–315). Naucalpan, México: G. Gili, S.A. de C.V., Ediciones.

Presidencia de la República, Fundación éxito, & AEIOTú. (2011). Memorias Lanzamiento estrategia Nacional de cero a Siempre. Atención integral a la primera infancia. Bogotá, Colombia: Presidencia de la República. Retrieved from http://www.deceroasiempre.gov.co/

Programa Buen Comienzo, & SEN. (2012). Resolución No. 501 de 2012. Medellín, Colombia: Secretaria de Educación Nacional, Alcaldia de Medellín. Retrieved from http://www.medellin.gov.co/

Toranzo, V. A. (2007). *¿Pedagogía vs Arquitectura? Los espacios diseñados para el movimiento*. Universidad de San Andrés. Retrieved from http://www.udesa.edu.ar/files