Kindergarten physical setting guidelines: a review from indoor air quality perspectives

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Abstract. The kindergarten's indoor air contained a number of pollutants, including total volatile organic compounds, particulate matter, carbon monoxide and insufficient ventilation with high carbon dioxide levels, which exceeded the indoor air quality (IAQ) guideline. The presence of these pollutants is caused by various factors including inappropriate physical setting. Indisputably, authorities throughout the countries provide guidelines for designing kindergartens' spaces, however it is limited to general explanations and only guided by early education compliance. It is vital to determine which kindergarten regulations may contribute to poor IAQ. This paper explores national kindergarten physical setting guidelines and how it affects IAQ. A document analysis method was used to determine the characteristics and differences between kindergarten guidelines. Firstly, the composition of each kindergarten guideline was itemised. Then, the study was conducted by making comparisons of the identified items. All the criteria were further reviewed from IAQ perspectives. This study was conducted on guidelines in Australia, Canada, the United States, Singapore and Malaysia. There are five physical setting requirements that influence IAQ : minimum indoor space required per child, sleep area, kitchen and food preparation area, ventilation requirements and furniture and finishes. All activities happen in this microenvironment contribute to IAQ, which is also affected by the ventilation system, furniture and finishes selection. It can be concluded that there is still room for improvement in existing guidelines by taking into account the indoor air perspective. Aside from the main function of kindergarten to provide education, the physical setting of kindergarten also plays a significant role in the growth and health of chidren.

1 Introduction

Early education has become an essential component of children's social development and the future of society. Many governments and stakeholders around the world have put forward their focus on children's development, learning opportunities, and healthy living. Each country has preliminary school education regulations and has been a subject considered in a systematic education system [1]–[3]. Looking at the global scale, the UNESCO Incheon Declaration and Framework for Action 2030 underline the endeavour of Sustainable Development Goal (SDG) 4 for education to ensure that everyone has access to quality education, a safe learning environment and given a chance to learn throughout their lives.

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By 2020, the SDG 4.2 aspires to provide children with quality early childhood development, care and pre-primary education to prepare them for primary education [4]. However, for kindergartens to fully maximise the children's development, kindergarten lessons must be conducted not only using high quality curriculum and pedagogy but also in high quality physical environment [5].

In general, the kindergarten layout can be divided into five spaces as suggested by [6], i.e., entrance, learning area, playing area, kitchen and toilet, depending on the activities and learning practises of the children. Ideally, the space can be segmented into wet and dry regions and further subdivided regions into zones, such as an active zone, a quiet zone and an outdoor [7]. However, there are kindergarten buildings that were not initially designed for kindergarten purposes and require some alteration to meet the authority's establishment requirements. This may influence the kindergarten's space allocation and congestion [8]. Research conducted by [9] revealed that over 90% of randomly sampled classes (a total of 711 classrooms) were less than 2 m² per person, indicating that these classrooms were unable to accommodate the appropriate number of children as per guidelines. In other case studies, inappropriate space allocation such as separating the dining area from the classroom by placing the dining area in the kitchen area, was observed [8]. The inappropriate space allocation contributes to poor indoor air quality (IAQ).

[10] stated that crowded classrooms and play areas were significantly associated with higher carbon dioxide (CO_2) and particulate matter (PM) concentration levels. Similar findings were obtained in the study by [11], which investigated the microbiological and chemical quality of indoor air in Slovenian playrooms. The authors emphasised that in 89.3% of playrooms, the CO_2 concentration exceeded the maximum limit of 1000 ppm. Although CO_2 is not a pollutant, a concentration of more than 1000 ppm in kindergarten classrooms indicates that the space is not sufficiently ventilated [12]–[14]. In Korean childcare centres, the total concentrations of airborne bacteria (TBC) and fungi (TFC) were averaged at 931 and 536 CFU/m^3 and the values are the highest among tested public buildings; hospitals, elderly welfare facilities and postpartum nurse centres [15]. TBC level also recorded the highest with mean 1251 CFU/m^3 in three Turkey kindergartens compared to other indoor environment buildings [16].The possible contributors to the highest level of TBC and TFC are the higher occupant density, poor ventilation and the existence of kitchen and the bathrooms, high RH and substrate presence at levels that promote the biological growth [17]–[20]. It can be seen that the kindergarten physical setting impacts IAQ.

Each country has kindergarten education guidelines affiliated with public and private kindergarten institutions. These guidelines outline the preschool education system's goals, guiding principles, operation, philosophy and instructional approach. The regulation is organised according to cultural, socio-economic aspects, as well as physical setting, usage rules, furniture, equipment and educational tools. Although the kindergarten guidelines have regulated the requirement for physical settings, kindergarten still faces the above mentioning problems. It becomes clear that the guidelines for establishing kindergartens are still immature, making it significant to contribute to its betterment. Studying the existing kindergarten guidelines and improving it based on IAQ findings is essential.

This study aims to present a document analysis study that examines different data in order to determine appropriate spatial conditions. Our specific objectives are to (a) identify physical setting requirements in kindergarten guidelines that affect IAQ; (b) compare the similarity and differences of each guideline; and (c) review the guidelines from IAQ perspectives. The research findings can assist in improving established kindergarten guidelines and easing the kindergarten operators in the preliminary setting of their premises.

2 Materials and method

This study has used a document analysis method to determine the characteristics and differences between kindergarten guidelines. Document analysis is a type of qualitative research that employs a systematic approach to assess document-based data in order to respond to particular research questions. Document analysis requires evaluating, scrutinising, and finally interpreting data to understand the studied structure accurately. As a first step, the composition of each kindergarten guideline was itemised. Then, the study was conducted by making comparisons of the identified items. This study was conducted on kindergarten guidelines in Australia, Canada, the United States, Singapore and Malaysia, as stated in Table 1. The criteria for selecting kindergarten guidelines were limited to English language documents, similar space division and available full versions. All guidelines included child care and kindergarten provision and separate requirements according to age groups.

Table 1. The guidelines of the kindergarten were reviewed

Country	Guideline Title (Year of Publication)
Australia	Design Guide for Victorian Children's Services (2005)
Canada (City of Vancouver)	Childcare Design Guidelines (1993, updated January 19, 2021)
United States	U.S General Services Administration Child Care Center Design Guide (2003)
Singapore	Guide to Setting Up Early Childhood Development Centre (2019)
Malaysia	Guideline on the Establishment of Kindergarten and Child Care Centre (2017)

The scope of discussion is limited to requirements that have an effect on IAQ. The minimum floor area indicates the size of each class's allocation. CO_2 emissions increase proportionally with the number of students in a classroom. The sleeping area is where children sleep for an extended period (between two to three hours). CO_2 generated during sleeping activities accumulates over long hours. A kitchen is a location where cooking activities take place. This activity adds to the production of particulate matter with aerodynamic diameter ≤2.5µm ($PM_{2.5}$) and carbon monoxide (CO). The ventilation system has an effect on the CO_2 and particulate matter with aerodynamic diameter ≤10µm (PM_{10}) levels in a building. Furniture and finishes lead to the increase of volatile organic compounds (TVOC), bacteria and fungi.

3 Results and Discussion

The analysis focused on five main kindergarten requirements influencing indoor air quality: the minimum floor area, sleep area, kitchen and food preparation area, ventilation, furniture and finishes. A comparison of these five requirements is discussed in each selected guideline.

3.1 Minimum floor areas

3.1.1 Kindergarten guidelines

All kindergarten guidelines have defined a guiding principle for the space that should at least be available to children. The indoor space should be large enough to accommodate a desirable number of children. The accommodation capacity is calculated using the areas designated for teaching and learning. The area assigned for children's activities does not include the floor used for circulation, furniture, classroom support, and centre support. There are minimum floor area standards for every country. The requirements range from less than 3 square metres to 4.4 square meters as stated in Table 2.

In the Internal Spaces chapter in Design Guide for Victorian Children's Services, as a reference to the Children's Services Regulations of 1998, where in its regulation 42 stipulates that the classroom shall 3.3 square metres for children younger than 3 and older than 3 years old, excluding the space occupied by permanent furniture. Under item 2, Facility Size and Shared Spaces in the City of Vancouver Childcare Design Guidelines states an area of 3.9 square metres for preschool children (part-time) with reference to 20 space program and net activity area is 78 square metres. The Child Care Center Design Guide. In the U.S GSA- Child Care Center Design Guide under Chapter 5 of Space Planning and Location, for a group of 20 preschoolers, the minimum size for classrooms is 4.4 square metres per child. The classroom area does not include support areas such as cubby storage, sinks, toilets and storage.

In Singapore, the capacity of kindergarten is determined based on the space dedicated for teaching and learning and excludes other service areas. The presence of adequate sanitary facilities and space for gross motor activities is also a prerequisite for accommodation capacity. For Class B Licence (full day for children from 18 months to below 7 years old), the accommodation capacity is computed based on 3 square metres of floor space area for each child. For Class C Licence (half day for children from 18 months to below 7 years old) , the accommodation capacity is computed based on 1.88 square metres of floor space area for each child [21]. Malaysian Guideline on the Establishment of Kindergarten and Child Care Centre in item 7 of Planning Guideline subsection 7.6 Minimum Space Requirements for Children states an area of 1.4 square metres for children in groups up to 25 children, and net activity area is 35 square metres.

Table 2. Minimum indoor space

Country	Minimum indoor space required per child
Australia	3.3 square metres for each child
Canada (City of Vancouver)	3.9 square metres for each child
United States	4.4 square metres for each child
Singapore	3 square metres for each child (full day registration) 1.88 square metres for each child (half day registration)
Malaysia	1.4 square metres for each child

From the guidelines above, each country has a different minimum amount of indoor space per child, with the United States having the highest and the lowest in Malaysia. For example in Malaysia, a provider who wishes to care for ten children in a single children's room, must have at least minimum 14 square metres of clear space accessible in that room (1.4 square metres for each child x 10 child). Although the provider complies with this minimum allocation of space per child, it impacts IAQ especially high buildups of CO_2 concentration levels.

3.1.2 Indoor air quality research in the classroom

High CO_2 concentrations and insufficient ventilation were documented in kindergarten classrooms worldwide, according to research conducted in Portugal [22], [23], Poland [24], France [25], Korea [26] and Malaysia [14]. A study in Portugal found that CO_2 concentration in kindergarten classrooms was high and several times exceeding the Portuguese standards. The high concentration happens because of overcrowding. Surprisingly, the number of children per classroom was always found according to Portuguese legislation for educational purposes [27]. In Malaysian kindergarten, it is observed that most classrooms had a higher number of occupants; during activity in class, the CO_2 levels increased and exceeded the reference value of 1000 ppm [14]. Findings from [28] indicate that indoor CO_2 concentration exceeded 1000 ppm in classrooms with more than 15 children. In a fieldwork study conducted in Canada, 71% of childcare centres had an average floor space equal to or higher than 2.75 square metre/child for children older than 18 months, which complied with the provincial standard. The mean CO_2 concentrations were found to be substantially lower than in centres that did not meet floor space requirements [10]. Another indoor air pollutant recorded is PM and it associated with classroom density. In Taiwan kindergarten, PM concentration was lower in classroom with low occupant density; one person per $10m^3$ compare to classroom with three people per $10m^3$ [29].

3.1.3 Suggestions

From an IAQ standpoint, classroom density is recommended to adhere to the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Standard 62.1-2019 specified criteria of 25 people per 100 square metres for 5 to 8-year-olds, representing 4.00 square metres for each child [30]. The appropriate indoor space per child is that higher than national recommended minimum value, provides more area per child within classrooms, and the space is equipped with proper ventilation system [31]. Otherwise, this enclosed area may have a higher risk of virus transmission if overcrowded [32].

3.2 Sleep area

3.2.1 Kindergarten guidelines

Napping is an essential routine in child care. Most children take regular afternoon naps while they are in kindergarten. The comfortable space for napping helps children relax and get the rest they need. As stated in item 7.6, Loft and Platform in the United States guidelines, there is no express designated sleep area in kindergarten. However, it takes place in the classroom. There will be cots to sleep in, which can be stored in the classroom when not in use. Storage spaces for cots/mats must be designated. In Australia, reference to Children's Services Regulations 1998 Regulation 49 provides that operator is required to offer suitable beds, cots, beds, mattresses or stretchers for the use of children while they are sleeping. Cots must be stored away after use. Permenant cots cannot be counted as part of floor space calculation [33]. Under item 3 Internal Design Consideration in Childcare Design Guidelines determines that the nap room should appropriate to accommodate all napping children and allow them to sleep undisturbed by nearby activities. This nap room also can be used interchangeably as activity room. This space can be set up for activities including storage [34]. The sleep area requirement only includes the need for sleep, and this requirement is not stated in the Malaysian guideline [35]. Children usually sleep on cots or mats in the classroom, which are stored when not in use.

In the guidelines, the division or allocation of the napping area is not explicitly explained. Long sleeping activities (two to three hours) cause a buildup of CO_2 if the space is overcrowded and lacks an adequate ventilation system. Using a mattress as a sleeping pad also increases PM during sleeping preparation.

3.2.2 Indoor air quality research in sleep area

In addition to the classroom, the sleeping room is also a focus of the investigation. In sleeping rooms, PM concentrations increased before and after naps, probably due to re-suspension processes related to the setting up of the sleeping need and the presence of children. In addition, during the second campaign, [36] also discovered PM concentration remained high in the classroom taking into account all activities (morning reception before lessons, playground time, nap time, and activities after classes). Recent research conducted by [37] also observed that $PM_{2.5}$ concentrations are higher in the bedroom than in younger children's classrooms. It is agreed with the previous finding that the use of bedcovers while setting up afternoon nap is the determinant of higher concentrations of $PM_{2.5}$ in the bedroom. Besides high PM concentrations during nap time, CO_2 concentrations were also higher during this period. The action of closing windows and doors to ensure silence during nap time has the effect of reducing ventilation [36]. This finding is similar to that of [23], who discovered that the CO_2 level were highest (7448 mg m^{-3}) when the window was closed for an extended time in the morning and during sleeping period (12.00 to 15.00 h). CO_2 started to decrease when the windows were opened after the sleeping period. [38] assessed PM and CO_2 in winter seasons in four naturally ventilated preschools in Gliwice, Poland. Their findings show that classrooms with older children had greater concentrations of PM (PM_1, $PM_{2.5}$, PM_{10} and TSP); whereas classes with younger children who slept in the afternoon had higher concentrations of CO_2. Aside from the most substantial effect of high CO_2 during classroom teaching hours, the afternoon nap role appears to be another contributing factor as also evidence in [39] research . In reviewed studies by [40], authors suggested that, because higher CO_2 concentrations were frequently found during nap, sleep time and sleeping-only rooms should be of particular importance.

3.2.3 Suggestions

The sleeping location should be defined in the rules and positioned in a space apart from the classroom, such as an open area with natural ventilation. An adequate ventilation system is a must if there is a designated sleep room. Using another location for naps assists any CO_2 concentrations that may have accumulated in the classroom during the learning period to decrease before the next session [41].

3.3 Kitchen and food preparation area

3.3.1 Kindergarten guidelines

Every kindergarten should have a designated space for preparing food and snacks. The size of kitchen depends on the type of food service the centre offers as per the specifications listed in Child Care Center Design Guide (7.6 Lofts/Platforms). The kitchen is mainly needed for preparing basic meals and a place to receive catered meals. The kitchen is recommended to be situated centrally with access to the service entrance, close to the multiple-purpose area, but away from the classrooms. Proper ventilation, lighting and clearances must all be adequate. Design Guide for Victorian Children's Services determines kitchen requirements according to the program offered, if long day care is involved, then the large kitchen will be utilised to prepare a few meals for all children. The suggested kitchen location is partnered with a dining room or adjacent to the children's room [33]. Under item 3.2 Support Spaces in Childcare Design Guidelines determines that kitchens should be located and designed near the Activity Room so that staff can keep an eye on children while they are in the kitchen. The kitchen should not be in the way of other service areas like the laundry room, janitorial and washrooms [34]. In Malaysia, cooking activities are only permitted to be carried out by means of electrical appliances or electric stoves. Gas stoves (LPG) are allowed if the kitchen area and other areas are separated based on the provisions of the Uniform Building Bylaws (UBBL) 1984.

The location of the kitchen is suggested to be in a place that is easy to see such as near to children room or activity room. There is no explanation related to additional ventilation system that needs to be there when cooking activities are done. It was discovered that extensive cooking contributed considerably to higher PM and CO concentrations.

3.3.2 Indoor air quality research in kitchen

Another microenvironment that contributes to poor IAQ is the kitchen. An examination of three nurseries in Portugal indicated that the mean particle concentrations ranged from 1.15 to 1.82 x 104 particle/cm^3 respectively. The canteens area had the highest levels of ultrafine particles (UPF), most likely because the space was close to a kitchen with gas stoves [42]. In another kindergarten located in Złoty Potok, Poland, a kitchen coal stove was utilised, resulting in elevated levels of sulfur dioxide (SO_2) indoors [43]. [44] investigated the association between IAQ and health outcomes in children. The authors emphasised that $PM_{2.5}$ is significantly associated with respiratory inflammation. One contributing factor is that the kitchen is close to other rooms, which means children are exposed to cooking smoke while preparing meals. [45] performed a study on 10 urban daycare centres in Negeri Sembilan, Malaysia and included 90 children. One of the findings indicated that cooking activities in the kitchen contributes to higher concentrations of $PM_{2.5}$ and may raise the risk respiratory diseases in exposed children. Another identified IAQ parameter in the kitchen is carbon monoxide (CO). In addition to external traffic, the kindergarten kitchenette stove could be a source of CO in the indoor air [26], [46].

3.3.3 Suggestions

Based on the guidelines, the preparation of food is determined by the kindergarten provider whether it is outsourced or cooked in-house. If food preparation involves cooking, the location of the kitchen should be considered. Extensive cooking activities were found to contribute to elevated PM levels. In particular, frying was significantly associated with elevated PM, especially finer fractions (i.e., PM1 and PM2.5)[47]. It is found that opening wide windows during cooking, does not diminish generated particles in the air [48]. Open windows may result in cold and discomfort for occupants. The kitchen needs to be equipped with exhaust fans or ventilation hood. Additionally, a partition is required between the kitchen and any spaces especially the classroom to prevent infiltration of excessive $PM_{2.5}$ and CO [49]. The best way is to eliminate cooking activities in this confine space.

3.4 Ventilation

3.4.1 Kindergarten guidelines

Ventilation is essential for the proper air comfort of a space used by children. Thus, comfort can be increased by enhancing the ventilation system. The United States outlines more detailed requirements related to ventilation with CO_2 monitoring and thermal comfort requirements in the building during winter (21°C temperature; 35 % minimum relative humidity (RH)) and summer (24-26 °C temperature; 50 % maximum RH). Each microenvironment shall be supplied with a minimum of 15 liters/second (L/s) of fresh air. Provider also suggests to use indoor plants where it may improve IAQ by filtering pollutants out of the air [50].

Naturally ventilated rooms are permitted under the Building Code of Australia (BCA), provided they adhere to section F4.6 of the code. The use of fixed ventilation (wall grates and sash vents) should be evaluated for efficiency. Fixed ventilation may hinder thermal performance by permitting hot air into a building or allowing cool air to exit. Designing the doors and windows should strike a balance between the need for safety and the desirable natural airflow. For instance, double-hung windows (sashless or otherwise) let air flow naturally while keeping children safe from the dangers of other types of windows. The efficacy of natural ventilation relies on cross ventilation. Cross ventilation must be designed to seek a balance between natural ventilation and the drawbacks of draughts. If there are no mechanical cooling systems in the centre, ceiling fans might be an option. All restrooms, bathrooms and diaper-changing spaces should have intense exhaust fans.

In Singapore, all spaces with operable windows and doors must be ventilated daily to maintain good air quality. If the window can not be opened, air purifiers can be utilised to improve and maintain air quality. The rooms' temperature must be maintained at an optimal level for activities to take place. Fans or air-conditioning units can be used to regulate the rooms' temperature and ventilation needed [21]. Concerning ventilation, Malaysia does have regulations on this though it is in a general form with an obligation to follow UBBL 1984 and Fire Department Regulations. All guidelines emphasise the need for natural ventilation in kindergartens to preserve good air quality.

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3.4.2 Ventilation in kindergarten

Natural ventilation through frequent window openings affects the rate of air exchange [51] and can eliminate or dilute indoor air pollution (IAP). One research claimed that opening a single window enhanced the air change rate by an amount typically equal to the opening width, with rises as great as 1.3 air changes per hour (hr^{-1}). The air change rate rose from 0.10 to 2.8 h^{-1} when numerous windows were opened [52]. Mechanical ventilation maintains a consistent indoor room temperature, whereas natural ventilation provides higher air exchange quality. The central HVAC system had a fresh air intake control with a set fractional air exchange rate that could be employed to reduce pollution accumulation in the rooms. The minimum ventilation rates recommended by ASHRAE was set at 5 L/s per person for education facilities classrooms (ages 5 to 8) [53].Ventilation rates between 16 to 24 L/s per person have been shown to have positive impact on short-term absence rates, learning and performance [54]. There was no provision for air exchange in wall-mounted split air conditioning systems. Therefore, it is not recommended to install wall-mounted split units without a separate fresh air intake system [55].

The use of air purifiers could also aid in lowering IAP . The study conducted in two kindergartens in India found a decreased concentration of bacteria from 1178-1307 CFU/m^3 to 316-417 CFU/m^3 and fungi from 136-345 CFU/m^3 to 93-269 CFU/m^3 after installing an ozone air purifier[56]. This agrees with the finding of experiments in residential buildings [57]. [58] experimented with four kindergartens and concluded that classrooms' air quality when there is air purification was nearly 40%-50% better ($PM_{2.5}$ concentration reduction). In a similar context in China crossover intervention study, the concentration of $PM_{2.5}$ in kindergarten classrooms equipped with FAVS-HEPA (29.1 ± 17.9 μg/m3) was significantly lower than that without FAVS-HEPA (85.7 ± 43.2 μg/m3) [59]. Furthermore in recent research conducted in United Arab Emirates, the installation of an air purifier in a nursery considerably lowered the percentage of TVOC to 46.4%, and the concentration of total suspended particles (TSP) to 21.7% [60]. This is due to a high-efficiency particulate air (HEPA) filter, which removes suspended particulates.

3.4.3 Suggestions

All guidelines mention about the importance of fresh air. Fresh air in a space preserves thermal comfort, adjusts air humidity, eliminates odours, and reduces dust levels. Mechanical equipment, such as humidifiers /dehumidifiers, air purifiers, ceiling fans, and exhaust fans, can also aid in balancing IAQ. Priority must be given to the spatial design of the kindergarten, including the distribution of each area, particularly the placement of classrooms. There must be window openings in the classroom. Whenever possible, the planning and placement of windows should facilitate cross-ventilation. Increasing ventilation through opening windows and doors or employing extraction fans can assist reduce indoor pollution levels in crowded classrooms. However, improved ventilation/filtration methods should also be considered to reduce daily exposure of indoor/outdoor pollution. The ventilation rate (minimum 5 L/s as recommended by ASHRAE) shall be stated in the guidelines and calculated based on the number of occupants in the space[53].

3.5 Furniture and finishes

3.5.1 Kindergarten guidelines

Floor finishes of kindergarten suggested according to guidelines are carpet and the floor should not be of bare concrete. Carpets must be VOC-tested, have a green label, and have a high quality yarn system with stain resistance and non-PVC backing. Acrylic paint is often recommended for use on wall surfaces. Interior paint must be non-toxic and meet Green Seal's "Paints" criteria, which restricts VOCs to 50 grams per liter (flat) and 150 grams per liter (non-flat) [50]. The Singaporean guidelines stipulate that all furnishings and resources for children must be appropriate for their stage of development, age, size, as well as their intended activity use. Material selection must take into account the varied functions of each room.Carpet and vinyl flooring of high quality should be considered. Roll up rugs can be used in areas for quiet play and story telling [33].

3.5.2 Emission from furniture and finishes

Proper placing of furniture is also essential. Heat and humidity enhance the release of formaldehyde (HCHO) into the air. Therefore, putting that latest piece of furniture over or close to a heat source must be avoided [61]. [62] found that a 10°C variation boosted HCHO emissions by 1.9-3.5 times while a 35% rise in RH boosted emissions by 1.8-2.6 times. Therefore, increasing the ventilation rate in kindergarten, particularly after bringing new sources also helps reduce HCHO levels.

Soft carpet is a typical option for play spaces, yet it provides enormous surface areas and reservoirs for dust mite development and multiplication [63], [64]. According to study by [18] other sources of bacterial aerosol in kindergarten were bacteria associated with dust on indoor surfaces such as carpets and furnishings. Cleaning activities can cause bacteria on carpets and furniture to be resuspended. Carpeting, whether full or partial is associated with higher dust mite allergen levels. According to [65], the significant sources of bioaerosols are probably building occupants (children and their activities) and finishes like carpets that support microbial development. Mould levels were also much higher in carpeted areas [66].

3.5.3 Suggestions

Any flooring system requires proper cleaning and maintenance. In order to protect IAQ, carpet must be vacuumed regularly. With low-VOC cleaners, resilient flooring can be easily cleaned and maintained. In addition to overall composition, VOC content should be considered when selecting paint. The use of "zero-VOC" or "low-VOC" paints can reduce indoor air pollution. If a change in building material is being considered, it should be done during a lengthy break.

4 Concluding Remarks

Overall, the physical setting in the kindergarten is interrelated with all spaces. All kindergartens should have the suitable capacity to accommodate their children and activities. Kindergarten with a higher number of enrolments should be larger in size and vice versa. Some children's activities may require larger spaces than another.Contaminants from furniture, various play equipment and building materials were released and gathered in the enclosed spaces. Therefore, to maintain a healthy indoor air environment in kindergartens, adequate natural ventilation should be carried out before children arrive. A proper ventilation system in windowless classrooms should be emphasised, especially when fresh air intake is unavailable.

The review suggestion can be used to improve the existing guidelines.The requirement of this physical setting is not only looking at compliance with the education guidelines but also from the point of view of the implications for the children's health because they are in kindergarten for a long period. Indirectly, these actions will support the achievement of SDG of good health and well being of children. Carefully and deliberately arranging the kindergarten may offer a substantial dimension to children’s experiences and growth.

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