367

Investigation of spatial characteristics and refugee children's physical activity in micro-environments:

three refugee accommodations examples in Berlin

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ABSTRACT

Studies have shown that refugee children often spend considerable time inside refugee accommodations with temporary settings and have difficulties engaging in physical activity (PA), which is essential for their health and development. It is possible that the built environment around refugee children hinders them from being active. There is a strong evidence base for living environmental attributes associated with non-refugee children's PA. However, this evidence is unlikely to apply to refugee settlements, as they are unique and different from typical living accommodations. Thus, it is necessary to investigate detailed home /camp environmental factors in relevant contexts and their PA. This research focuses on how diverse environmental attributes in refugee accommodations are related to children's PA potentiality. Several different space syntax measures such as connectivity, step depth to internal and external PA spaces and global integration were used to analyse spatial characteristics of three study cases in Berlin, Germany. This research is conducted from July 2018 to February 2019. The key findings show that different refugee accommodations had differences in refugee children's PA potential. As an under-researched issue, this empirical material contributes to identifying micro-spatial characteristics and refugee children's PA. The design of refugee facilities should provide better access to internal and external PA spaces for children's play; moreover, spatial characteristics show the potentiality of considering an essential reference for the development of refugee accommodations.

KEYWORDS

1, built environment 2, active play 3, spatial configuration 4, barriers 5, refugee accommodation

1 INTRODUCTION AND DEFINITIONS

It is known that physical activity provides multi health benefits to children; it helps children build a robust body, stable mental health and healthy relationships with peers (Salvy et al., 2008; Mota et al., 2009; Ahn and Fedewa, 2011). Most literature reviews (Ferreira et al., 2007; Pinard et al., 2012; Kaushal and Rhodes, 2014; Cr et al., 2018) have focused on home built-environmental attributes associated with non-refugee children's PA, such as availability/access of exercise equipment and the use of exercise equipment. Refugee children live in very different home environments settings compared to non-refugee (Candappa and Egharevba, 2003; Korfmacher and George, 2012). For instance, their homes/accommodations have limited spaces for indoor playing (Allport et al., 2019; Arcan et al., 2018; Lewek and Naber, 2017), lack of communal facilities (Allport et al., 2019), or do not have enough 'dedicated spaces' for play inside the camp which provide safe environments for playing (Veronese et al., 2020). Thus, the existing findings of environmental attributes relevant to non-refugee children's PA may not apply to refugee children. The authors' previous review has identified that available indoor space and designated space for playing in micro environments is relevant to refugee children's PA (Chen et al., 2021); it is necessary to investigate further home/refugee camp environment attributes related to refugee children's PA. Moreover, the authors would like to identify several terms which will be discussed in this study:

1.1 Refugee accommodation types in Berlin

Figure 1 illustrates refugee accommodation types upon their asylum process in Germany, especially in Berlin. After asylum application submission (access) in arriving centres or nearest available refugee accommodations, refugee families will then be distributed to an initial reception (Federal Office for Migration and Refugees, 2018) as their first station in Germany for a short period. After their applications' evaluation, most families will be settled in community accommodation for a long time. As the last refugee accommodation of their asylum application, three conditions mostly happen after they move out of community accommodation: (1) move to a regular apartment if their asylum application is completed; (2) move to another community accommodation if this one is not available (e.g., closed); or (3) go back to their hometown if the asylum-application is rejected.

Furthermore, to cope with inadequate living situations, temporary living units as residential containers are built in Berlin, so-called "Tempohomes", refugees stay there for a transitional period until regular accommodations are available (Tempohomes FAQ, 2017). By data summarisation time, refugee accommodation systems in Germany are still under development, while new forms/prototypes of refugee accommodations are emerging.

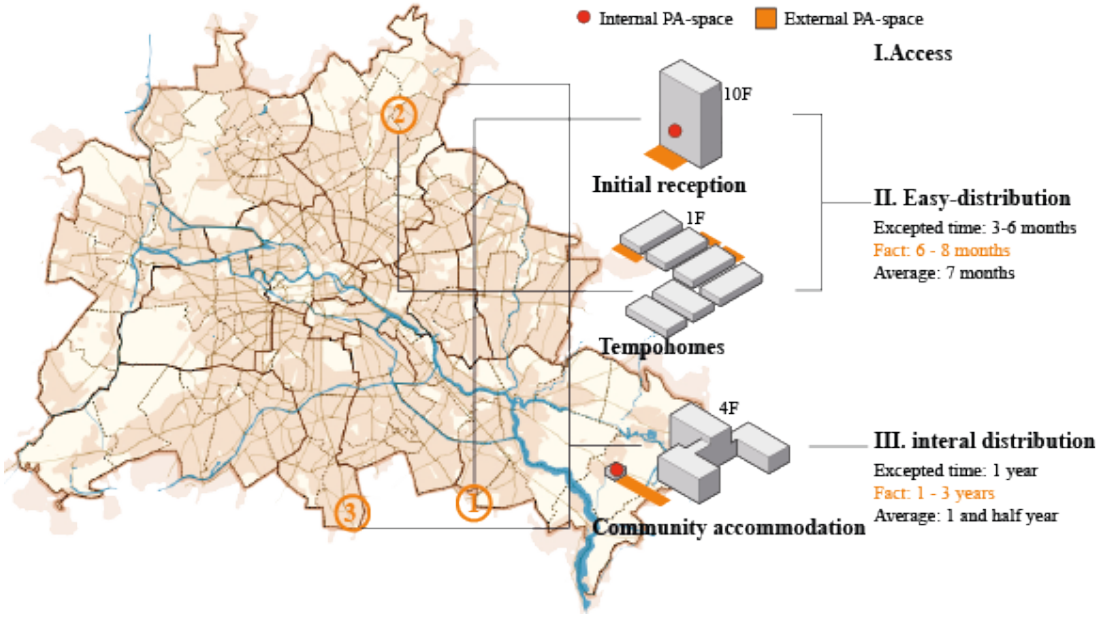

Figure 1: Investigated three refugee accommodations by types and geographic distribution

1.2 Micro environments

Much less research has focused on refugee accommodations and their surroundings at an individual built environment level (Edwards, 2004; Rima et al., 2006). For instance, Zeiher (2003) argues that some facilities are spatially limited and subject to temporary access restrictions since they are often designed by adults. There is no necessity and few opportunities for children to overcome these restrictions by exploring new activities or the neighbourhood, leading to spatially fixed physical activity structures (Kim et al., 2014). There is a need for a more specific definition of environments.

Bronfenbrenner's ecological systems theory (1986) has been applied as a framework to understand refugee children's day-to-day activities in this research (Yohani, 2008; McBrien and Day, 2012). The built environment around refugee children includes three environmental layers of interest: micro environment, meso environment, and macro environment. This research focuses on the micro environment as the immediate vicinity of the child's accommodation and contains the structures the children directly contact in their daily lives (McBrien and Day, 2012). As shown in Figure 2, examples include the home/refugee camp and its designated playground (Hjern and Bouvier, 2004). Refugee accommodations are centres of refugee children's built environments and daily lives. As mentioned before, the present studies show the issues of micro environments that affect children's daily life, such as lacking indoor space for privacy (Berthold, 2014), conflicts from space occupation (Anderson, 2001), or what this research concerns, refugee children themselves find 'no accessible place' for playing (Anderson, 2001; Berthold, 2014; BumF and UNICEF, 2016; Lewek and Naber, 2017).

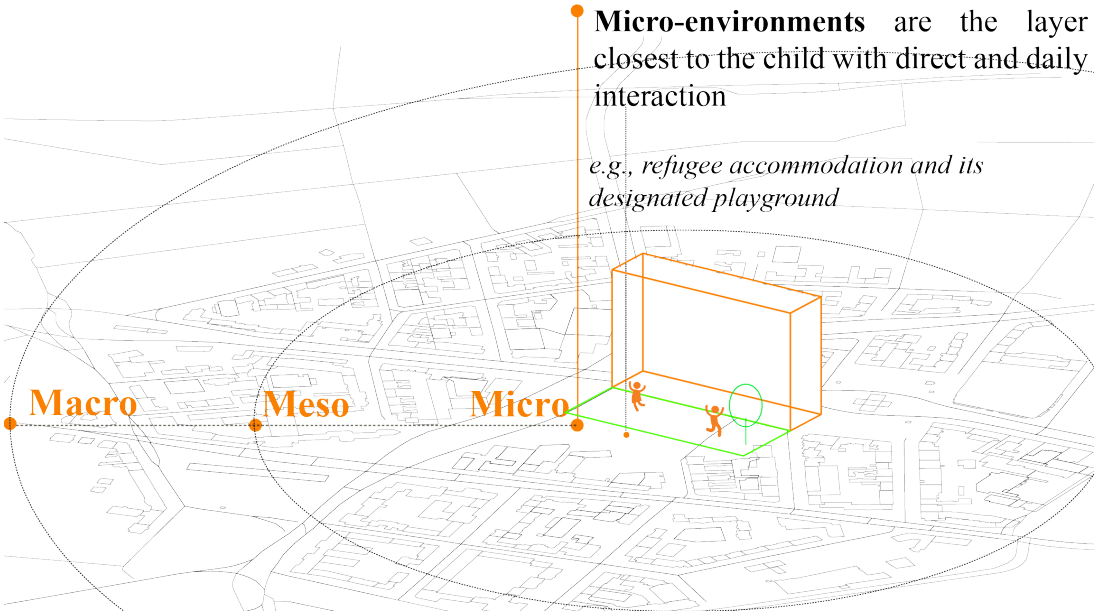

Figure 2: Diagram of environmental attributes on micro-level interacting with refugee children's PA

1.3 Internal and external PA spaces

In detail, spaces used for refugee children's PA in micro environments would be divided into internal PA spaces as designated playing spaces inside refugee accommodations (e.g., playroom, Figure 3, accommodation 1) and external PA spaces, which are referred to as outside playing space designated to this accommodation (e.g., playground, Figure 4, accommodation 1). In space syntax analysis, the calculation and investigation of residential spaces' external and internal integration values help explain the energy-related occupant behaviour such as PA in the spatial model's planning and organisation (Henk et al., 2013).

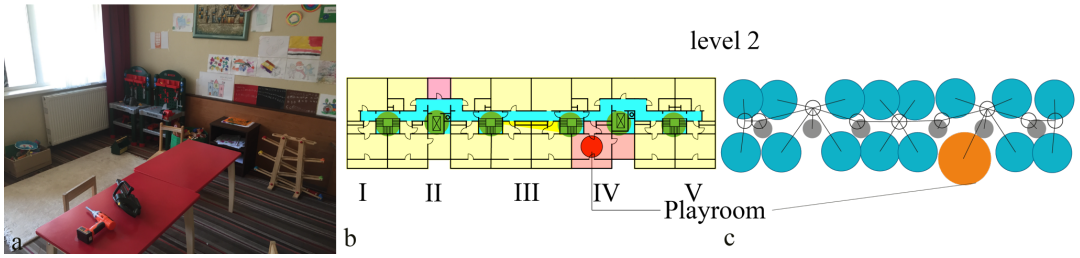

Figure 3: Internal PA space example (a) photo; (b) floor plan; (c) spatial analysis visualisation

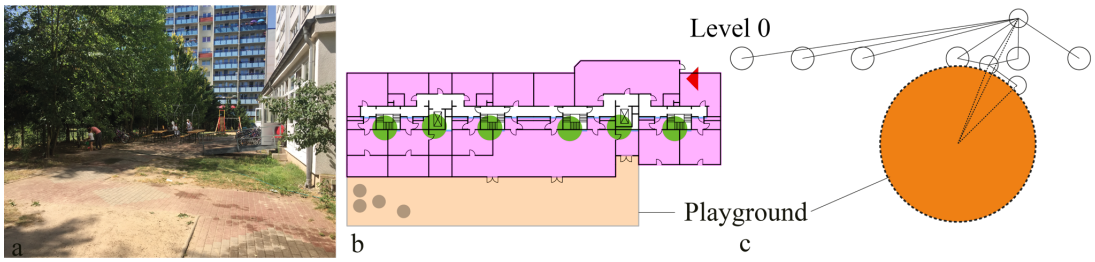

Figure 4: External PA space example (a) photo; (b) floor plan; (c) spatial analysis visualisation

1.4 Size and type of living units

As a supplement, this study used a four-person living unit (two parents and two children, Figure 6) for minimum spatial evaluation since it was the most common family component type in all staff surveys. Due to the Berlin Data Protection Act (Berliner Vorschrifteninformationssystem and Kopfbereich, 2018), International Refugee Law (IRL), superior protection specific protective terms of refugee accommodations and ethical considerations, family data targeted to individual refugee children and their parents could not be obtained for each accommodation. How children play inside their living units was unknown by the available database.

2 THEORETICAL BACKGROUND: SPACE SYNTAX

The potential of employing space syntax as a spatial measurement tool related to refugee children's PA seems multi-fold. To extend above mentioned 'refugee accommodations as micro environments', it space reveals the spatial organisation of facilities, traffic flow and their mutual intersections, the designated PA spaces – not only respond to the need to collect and children residents but intrinsically/should express what a configurational approach can make emerge and influence children's social and physical behaviour. Space syntax can analyse the physical environments, calculate the relationships between its spatial elements, and understand children's behaviours (e.g. PA), relying solely on the spatial characteristics of built environments (Lerman et al., 2014; Buonocore and Cutini, 2017). Previous research also showed the potentiality of space syntax works with refugee camps' built environments (Potangaroa and Chan, 2010a, 2010b).

Furthermore, configurational approaches investigated by space syntax can objectively substantiate the development and improvement strategies for refugee accommodations. In this sense, space syntax can act as a framework for overcoming accountability, economic, and political constraints limitations in such challenging contexts.

Application of space syntax in children's research concerning playing remains novel; in a short opinion essay, (Cutumisu and Spence, 2009) delineate why space syntax would be relevant in research relating to children's PA. First, aspects of the environment such as a sense of place may influence children's play, and space syntax has the capability to explain the walkability of the spatial configuration. Second, topology-geometric descriptors of space syntax resonate with how children develop and navigate spatial knowledge. The representation of built environments provided by space syntax might be fairer to children's perceptions. In fact, the authors are aware of only one study that has applied space syntax in the context of children's PA of associations between playgrounds accessibility and playing (Loit, 2021). The utilisation of space syntax in understanding refugee children's PA is relatively unexplored. This research is thereby contributing to the space syntax literature by exploring the broader application potential of its theories.

3 DATASETS AND METHODS

3.1 Study design and participants

As shown in Figure 2, three refugee accommodations have been investigated in Berlin on micro-environmental scales from July 2018 to February 2019, including one initial reception, one Tempohome and one community accommodation, namely accommodations 1 to 3.

Qualitative and quantitative methods are implemented in the study design: (1) identifying investigated accommodations and primary research data collection; (2) questionnaires (home manager and children care staff) based on accommodation types and micro environments; (3) field trips and semi-structured interviews with staff for indicating PA spaces and daily PA conditions for refugee children; and (4) spatial measures and accessibility of internal and external PA space through space syntax methods.

3.2 Measurement of PA

A previous review (Chen et al., 2021) shows that refugee parents have extra safety considerations for children's PA. Precisely, the author investigated PA as 'physical activity potential' based on staff surveys (questionnaire and interviews), including mainly two aspects: (1) organised activity (e.g., sports program) and (2) free play under staff supervision. Detailed subdivision of PA types could not be achieved due to limited access to refugee children and their parents (see Chapter 1.4). This material will be analysed with space syntax measures discussed in Chapter 3.

3.3 Application of space syntax and visualisation

Several different spatial measures were selected for the analysis as below:

- Connectivity is a dynamic local measurement that measures the number of spaces immediately connecting the space of origin (Hillier & Hanson, 1989). To simplify: connectivity is the number of connected neighbours to investigated space. It helps describe the relative level of control over the connected components (Wu and Guo, 2014). Connectivity is chosen in this study because it is one of the most used local measures and has been applied to refugee accommodation before (Buonocore and Cutini, 2017; Potangaroa and Chan, 2010b).

- Step depth illustrates which spaces are deeper and shallower than other spaces, related to the transitions formed by space connection (Hillier & Hanson, 1984). This measure has been used more often when investigating a specific space (Law et al., 2012; Talavera-Garcia, 2012). It was chosen for the analysis because it gives graspable descriptions

when comparing spaces. For example, suppose the step depth of a living unit is six; readers know it takes six math steps from here to investigate PA spaces (see Figure 9a).

- Global integration describes the average depth of space to all other spaces in the system (Hillier and Hanson, 1989). The spaces in a system can be ranked from the most integrated to the most segregated (A space syntax glossary, n.d.). The calculation and investigation of residential spaces' external and internal integration values in space syntax analysis help explain the energy-related occupant behaviour (such as PA) in the spatial model's planning and organisation (Henk et al., 2013).
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The accessibility graph is developed to express differences in spatial models by reconstructing and positioning a specific space at the starting point. In this study, accessibility graphs were obtained by SYNTACTIC (2018) in Rhino 6 environments. It was selected after several techniques attempting, representing a higher capability for space syntax calculation from multi-floor plans while giving more comfortable and graspable space descriptions. The authors reordered the colour coding of access graphs as (1) different colours represented different spatial functions (or floors), and (2) line links indicated if spaces were integrated or divergent; (3) sizes of circles represented actual comparable spaces size in scale. Conclusionally, the colour reordered coding follows the rules as below (see Figures 8 and 9):

- Solid grey circles represented stairs/elevators;
- Hollow black circles represented corridors;
- Coloured solid circles represented living units on different floors;
- Solid orange circles represented PA space (internal and external).

The summary statistics table and diagram will be combined with this graph as a supplemental explanation. Living units on the same floor will be divided into different zones with Roma numbers (e.g., zone I, Figure 8a) in complex floor settings. Multi-building or building complex will be numbered with varying alphabet characters (e.g., building a), while multi-external PA spaces as number 1 to N. Moreover, internal and external PA spaces will be investigated in one diagram if they connect directly (Figure 9c, accommodation 3). In contrast, two graphs will be located separately (Figure 9a, accommodation 1).

4 RESULTS AND COMPARISON

4.1 Spatial characteristics

Based on the information retrieved from the staff survey (30.07.2018), accommodation 1 is an initial reception that used to be a hotel. It has 11 floors with 100 individual living units, maximum of four people. 30 school-aged children (6 to 12 years old) lived in the accommodation. Families were expected to stay in this accommodation for not more than six

months. The internal PA space is one interior playroom on level 2 (Figure 5a), close to stairs and elevators. It is the same typology as a living unit with a balcony for two children's families (Figure 6a, 64m^2). To reach the internal PA space, children need to go outside their rooms, find the closest elevator/stairs, then get to level 2. The external PA space is on level 0, with a total area of 390 m^2. Children can arrive at this external PA space after passing through the canteen (only when it opens at mealtime), another corridor, or outside the main entrance. For spatial analysis, each floor will be divided into five zones (I to V) by corridors.

Accommodation 2 is a Tempohome, in which refugee families stay for a transitional period until there are available positions in other accommodations (see Chapter 1.2). It contains nine newly built one-floor container integrations: seven are living units for refugees (a to g, Figure 5b), while two are service rooms and offices. There are 64 living units inside the accommodation, mainly for four persons. As shown in Figure 6b, every living unit is a three-container combination with WC and a small kitchen (40m^2). By the staff survey period (14.02.2019), around 20-30 school-aged children lived here (detailed information could not be provided due to the operator's protection terms). There is no internal PA space but three small playgrounds (1, 135m^2; 2, 148m^2; 3, 103m^2); children can reach these playgrounds easily outside their living units.

Accommodation 3 is a community accommodation that used to be a retirement home. It has 90 rooms with family apartments maximum for six persons. It also has stringent protection standards as being fenced entirely and isolated from neighbourhoods. By interview time (20.11.2018), 18 people living here were school-aged, and families were expected to stay here for 1 to 2 years. Internal PA space is housed in a separate building with a play area on level 0 and separate rooms on level 1 (144m^2). External PA space as a playground (273m^2) is connected to the internal PA space. Children need to go outside to access the internal PA space. A typical 4-bed room for a family is 52.3m^2 with a balcony (Figure 6c), and there is a communal kitchen on each floor.

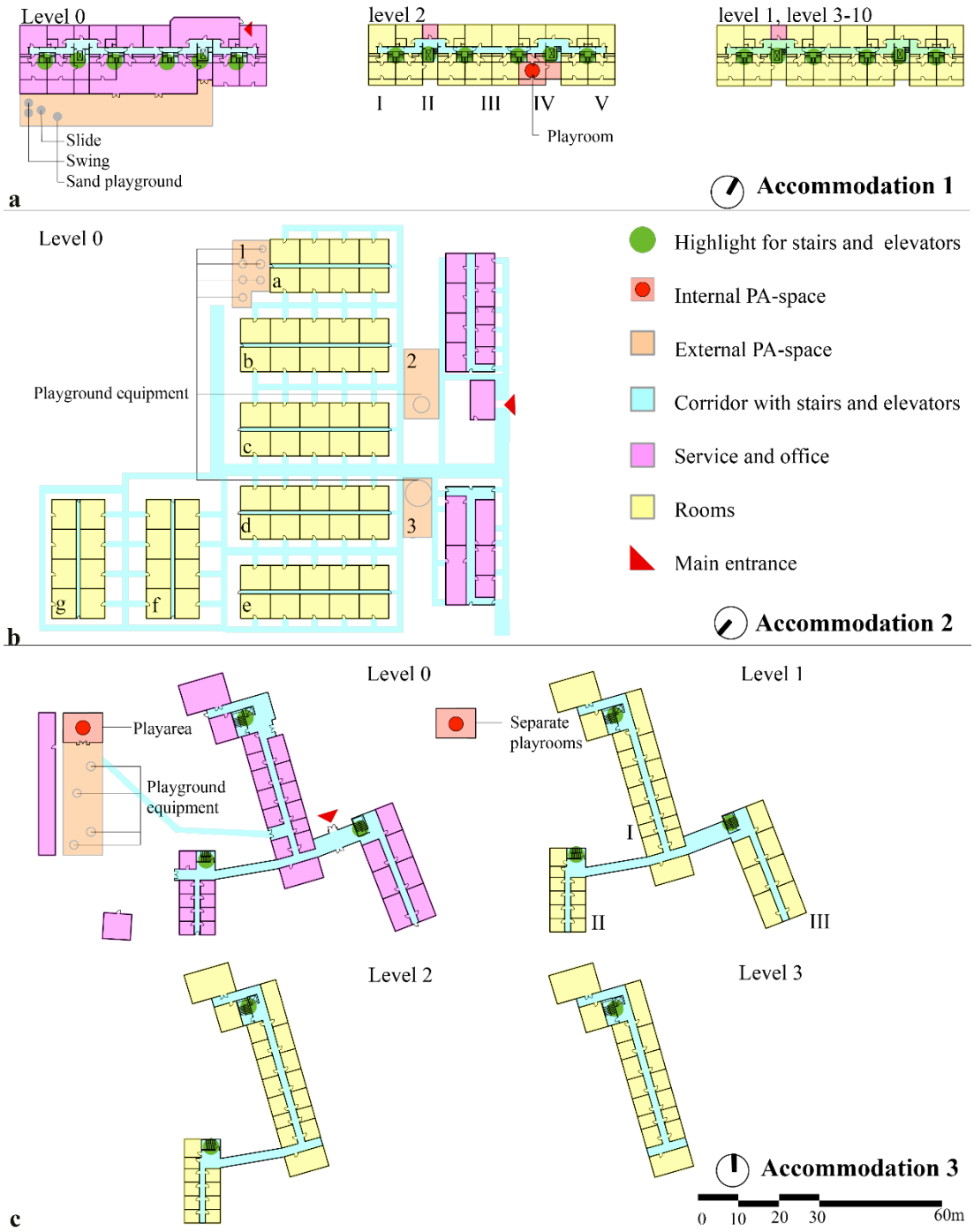

Figure 5: layouts of three accommodations: (a) accommodation 1; (b) accommodation 2; (c) accommodation 3

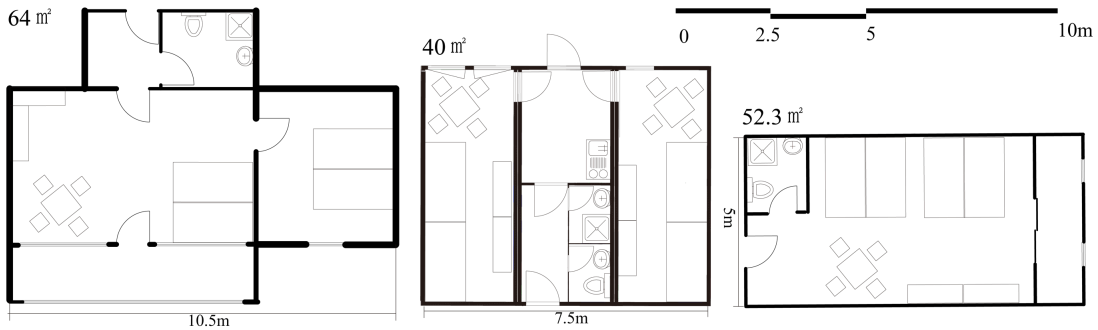

Figure 6: layouts of living units: (a) accommodation 1; (b) accommodation 2; (c) accommodation 3

4.2 Physical activity (PA) potential

As shown in Figure 7a, PA potential in accommodation 1 is from 16:30 to 18:00, around 1.5 hours per day under adults' supervision inside the accommodation. There is an organised football workshop every two weeks on Wednesday from 16:30 (playground).

Children's physical activity potential in accommodation 2 is from 15:00 to 18:00 (Figure 7b), around 3 hours per day. There are specific organised activities for children every Wednesday (17:00) and Saturday (18:00), and they usually play longer time (2 to 3 hours) in this organised activity.

Physical activity potential for children in accommodation 3 is from 15:30 to 18:00 (Figure 7c), around 2.5 hours, either in internal or external PA spaces under supervision. There are flexible workshops on soccer, badminton, and jump rope at the weekend. Parents usually go to this workshop together with their children.

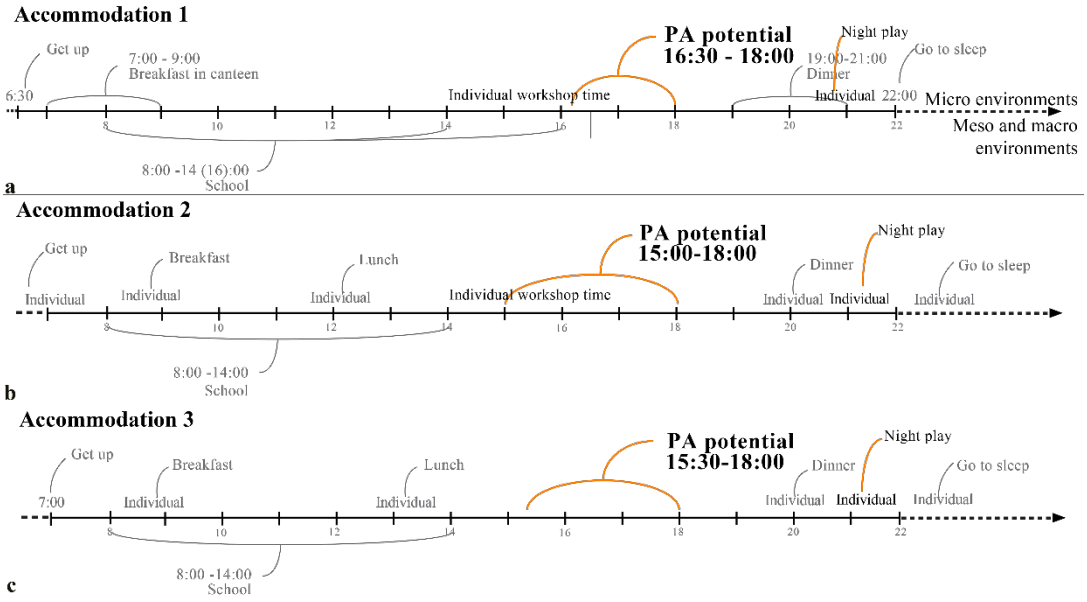

Figure 7: Daily PA timelines and PA potential of refugee children: (a) accommodation 1; (b) accommodation 2; (c) accommodation 3

Next to the PA potential described above, the data does not allow for an estimate of the quality or quantity of additional PA that may occur during school days. However, it is assumed here that accessibility to and from internal and external playgrounds has a role to play in any PA potential, which is investigated in the following section.

Connectivity

The connectivity analysis identifies that the integrated corridor on level 0 is the most connected (Figure 8a); the second corresponding parts are the main corridor (Zone I, II) that connect

directly to two stairs and one elevator on each floor. Even though every floor corridor is shaped like an entire rectangle, it separates into five spaces due to the old fire protection standard and former hotel design purpose. Translating these corridors' connectivity back to accessibility means that separated corridors increase the difficulties for living units to get to the internal and external PA spaces. The maximum connectivity is 8.0 (level 0 corridor), with the average connectivity being 2.3.

In accommodation 2 (Figure 8b), all three external PA spaces are in good connectivity with living unit containers with maximum connectivity is 46.0 (playground 1), followed by playgrounds 3 and 2 at 39.0 and 21.0. The average connectivity is 4.5.

As shown in Figure 8c, all living units in accommodation 3 have minimum connectivity of 1.0. The main corridor on level 1 was most connected as 36.0 due to the barrier-free design of the corridors and the former utility of a hospital. The average connectivity is 2.0.

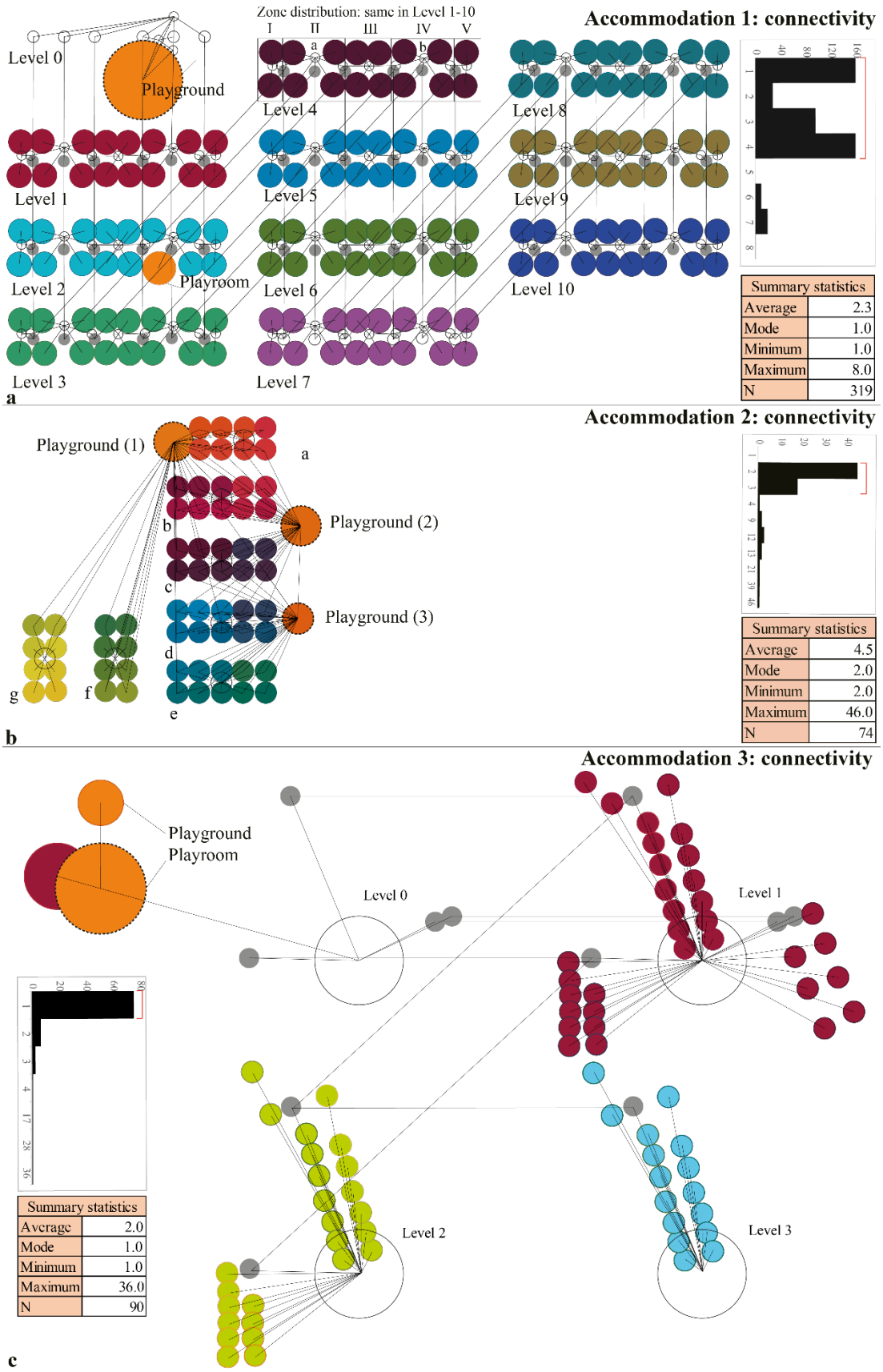

Figure 8: Connectivity analysis of three accommodations: (a) accommodation 1; (b) accommodation 2; (c) accommodation 3

Step depth to internal and external PA spaces

The step depth to the internal PA space (level 2 zone IV) strongly identifies Zone IV on each floor closest to the internal PA space (Figure 9a) in accommodation 1 since they connect through elevators. The second nearest parts are Zone III and V on each floor, where children go through corridors. Zone I is most far from the internal PA space due to separated corridors. The maximum step depth is 18.0, with an average step depth of 10.0. The external PA space step depth analysis strongly identifies that living units close to elevators and stairs are more accessible to external PA space (zone II and IV on each floor). For example, zone I, III and V on level 3, far from the stairs and elevator, may have the same 8.0 step depth as the stair corridor-related zone II and IV on level 4. Furthermore, accessibility decreases with floors. The maximum step depth is 15.0 (level 10, zone I, V). On average, every space is 8.6 steps away from the external PA space.

Children can easily reach external PA spaces outside the containers in accommodation 2 (Figure 9b). The maximum step depth is only two because few containers from buildings f and g are unlinked directly to the external PA space. On average, every space is 1.1 steps away from the external PA space. Only a few living units in buildings f and g do not connect to the playgrounds directly.

In accommodation 3, the step depth analysis identifies that the primary corridor on level 0 is nearest to internal and external PA space (Figure 9c). Due to the barrier-free corridors, living units on every floor have the same step depth to internal and external PA spaces. Almost the whole building is integrated with a maximum step depth of 7.0 from living units to the entire PA space and an average of 5.5.

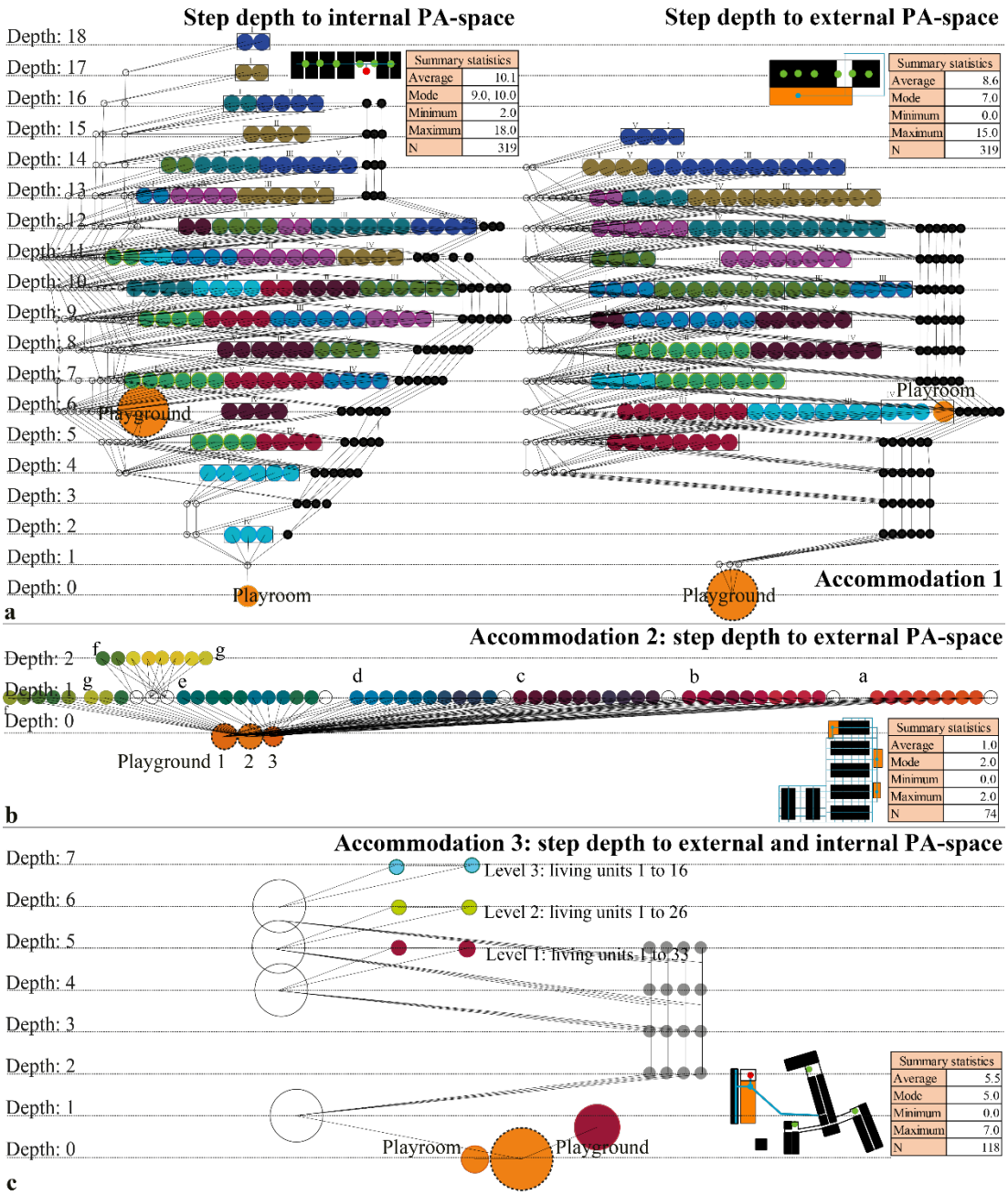

Figure 9: Step depth to internal and external PA spaces analysis of three accommodations: (a) accommodation 1; (b) accommodation 2; (c) accommodation 3

4.3 Summary of findings and comparison

Figure 10 compares the abovementioned investigated spatial measures and provides an overview of spatial characteristics based on typology. In summary, 11th-floor accommodation 1 had inconvenienced corridors and multi-floors, making it most difficult for children to reach external PA space (highest step depth), internal PA (highest step depth), and the lowest integration values. Such spatial characteristics give low accessibility for PA spaces internally and externally. On the other hand, it has the most significant living unit at 64 m^2. Children in 1 had the least opportunities for PA.

One-floor accommodation 2 with multi-track typology had the highest connectivity and integration value. It was also nearest to the external PA space in step depth. Such spatial characteristics provide the potential for PA space accessibility. However, there is no internal PA space, and the living unit is the smallest (40m^2), which may reduce the chances of PA when the situation (e.g., weather) is not suitable for outdoor playing.

On the other hand, fifth-floor accommodation 3 children had the most opportunities for PA. It has average PA space accessibility with average step depth and connectivity. Even though the corridor is accessible, prominent and well-integrated, separated internal and external PA spaces reduce accessibility for children to enter. It also has a living unit with a middle size of 52.3 m^2. Children's opportunities for PA in accommodation 3 were medium in their lengths.

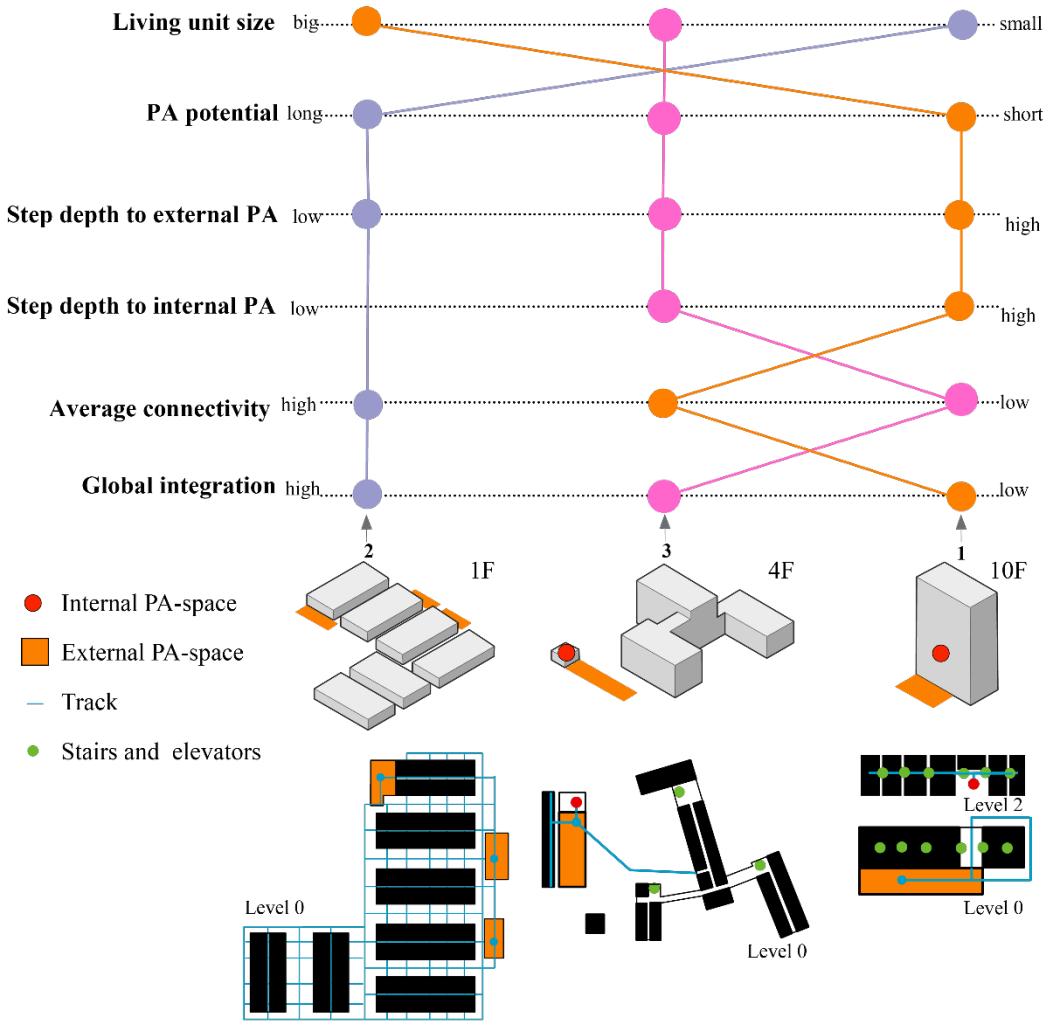

Figure 10: Comparison of overall findings of three study sites with typology

5 DISCUSSION

The empirical results reported herein should be considered in light of some limitations. Firstly, the authors have had limited ability to gain access to the appropriate type or geographic scope of participants due to the realistic situation of refugee contexts. This research had a small sample size; therefore, a limitation for the volume of data collection within the scope of this study. Thus, the study site was not random sampling but involved refugee accommodation participants willing to collaborate in this research. It may raise the issue of identifying significant relationships in the data. However, this study aimed to provide initial investigations between spatial characteristics and refugee children's PA. Hence, what is generalisable from this study is more of an analysis than the direct results. Secondly, the staff surveys of 'physical activity potential' presented may have low reliability. The ways in which the authors have measured PA have limited the ability to conduct a thorough analysis of the results. More precision analysis and accuracy results concerning children's PA should be investigated in future studies. In general, this is a cross-sectional study, and depending on the scope, relevant studies on this topic are limited; however, in this case, this study has been able to identify literature gaps and present the need for further development in the study area. To confirm if environmental design influences PA, a longitudinal or experimental study should be developed in the future. One possibility is to track PA before and after transitions to refugee accommodation as a quasi-experimental study.

6 CONCLUSIONS AND RECOMMENDATIONS

Studying the existing built environments for refugee children's PA is a highly complex undertaking due to restricted access to accommodations and the vulnerable conditions of this population group. This study presented new and rare empirical material of the spatial organisations in a small sample of three Berlin located refugee accommodations using different spatial measures: connectivity, step depth to PA space (internal and external) and integration. Due to limited samples, the study cannot conclude with correlations between spatial characteristics and refugee children's PA but attempted to describe the nature of relations nuancedly in 3 selected typologies. This research drew attention to spatial characteristics of refugee accommodations and provided a first evidence base on which to evaluate the design for new built / or existing accommodations for refugee children's PA purpose. This Berlin micro environment scales research also has the possibility to be applied in other urban contexts of refugee accommodations. These examples are essential in presenting and drawing attention to creating more active built environments for refugee children, especially in the design and re-functionalised (for existing buildings) phase of refugee accommodations. Below are specific recommendations for related practitioners:

- Refugee accommodations should provide multiple playing spaces with equal access for children from each living unit;

- Internal PA spaces should be included when designing/re-functionalising refugee accommodations; precisely, space syntax can help to identify the location of PA spaces (e.g., accommodation 2 with missing internal PA space) that are most accessible for each living unit;
- Besides investigated spatial measures, quality aspects of PA spaces (e.g., the presence of play equipment, lighting, maintenance) should be investigated in the future.
- Besides micro environments, further studies should understand the role of meso (e.g., neighbourhood) and macro environments (e.g., transportation system) in refugee children's PA
- Further studies may use the spatial variables that were identified here as necessary to compare with further refugee accommodations and with non-refugee children.

Given this research's focus on refugee children's PA, the authors could not find any research regarding space syntax's role in related research in micro environments. It seems to be a new window to begin such research: space syntax shows the potential to work with comprehensive topographic layouts; therefore, in line with data and privacy needs.

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