MC 2020 Proceedings of 10th Masters Conference: **People and Buildings**
Online, 18th December 2020
Network for Comfort and Energy Use in Buildings: http://www.nceub.org.uk

<<Healthy>> Housing for Children Living in Slums: A new assessment tool to score the impact of house environment on children's health

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Abstract: High child mortality rate is associated with extreme poverty and insufficient services, like in slums. To guarantee social equality since childhood, governments should plan improvements in living conditions, starting from interventions on existing housing. Assessing the healthiness of a house for children's health can help in prioritizing interventions. This study proposes a multi-factor assessment tool of house environment that ranks dwellings based on the risk that children (0-5 y/o) living in slums have on contracting five diseases with the highest mortality rate. The ranking scale associates dwelling and environmental factors with selected diseases through ORs. Final scores are standardized through coefficients, customizing results for the specific considered location. The assessment tool was tested on a database from slum's dwellings located in Delhi (India). Results showed usability and clear interpretation of final scores. With further literature, a more accurate and improvement to the tool could be possible.

Keywords: House environment, Health, Slums, Child mortality, Assessment tool.

1. Introduction

One billion people all over the world live in slums, informal settlements or overcrowded areas, and, among them, hundreds of millions are children (UNICEF, 2018). These circumstances are associated with poor housing (Ezeh, 2017), producing health and mental hazards that can be avoided by improving living conditions.

Slums are informal settlements where houses are inadequate and insecure, lacking access to improved water or sanitation, durability, security of tenure or sufficient living space (UNICEF,2012). It has been demonstrated that high child mortality rate is associated with extreme poverty and insufficient services, like in slums (UNICEF, 2017), as the lack of services, education, food, poverty, and infrastructure put them at a disadvantage from an early age, having a life-long impact (UNICEF,2017). Children vulnerability is connected to housing environment: the strong correlation between health hazards for children and inadequate housing has been demonstrated (Breyesse P. et al., 2004) (WHO,2019). Indeed, many dwellings' features increase the spread of infectious diseases and, consequently, child mortality. Children living in slums are considered the most vulnerable subjects from a health point of view, because of immature immunization and unconscious exposure to hazardous agents (WHO, 1989). They must be protected by social and political actions, to reduce social inequalities and guarantee equal social opportunities. The literature review highlights that an assessment tool that specifically investigates housing impact on child health in slums is needed.

This study aims to develop a robust assessment tool that considers multiple factors of the house environment and ranks dwellings as minimizing or maximizing the risk of children (0 to 5 y/o) living in slums to contract the five diseases with the highest mortality rate. The

developed method is based on an extensive literature review and intends to establish the basis for future research. The tool is meant to be easy to use and not time-consuming: identifying deficiencies to quickly plan impacting interventions.

2. Method

The tool was developed with the main aim of being simple to use and quick, representing an easy guideline to define improvements to be made. The methodology to develop the tool incudes three different steps of literature review.

2.1. Determine dwelling and environmental categories linked to inhabitants' health

Which features of a house are connected to health? To confirm and classify them into appropriate categories to be used in the tool, a scoping review was conducted. The aim was to identify key factors that relate house environment and health in slums.

Keywords such as «house», «dwelling», «slums», «housing» AND «health» were searched on PubMed and UCL Library Service. Considered papers had to be published less than 20 years ago, as habits of occupants, and physical/structural characteristics of housing are always changing. The selection by title was made including those that contained house features/hazards suggested by previous studies. The selection by abstract was conducted choosing papers that effectively linked a specific house feature to a health hazard. To maximize the amount of included papers, studies focused on informal settlements in general were included. Many studies that were excluded had a historical/narrative approach or were not focused on slums. Inspired by the Delphi survey technique (Hasson, 2000), if the association of a specific disease to an environment feature was reported by the majority (>50%) of the included studies, it was considered valid. If the majority of publications was composed of less than three studies, it was considered not robust enough, and the association was excluded. Examples are in table 2.1.

Table 2.1 – Example of dwelling/environmental categories heath, associated features, and possible outcomes.

Dwelling and environmental categories	**Associated dwelling and environmental features**	**Examples of possible health outcomes**
Drinking water	Contamination, waterborne disesases	Diarrhea, respiratory, diseases, cardiovascular diseases
Sanitation	Water, sanitation falicities	Diarrhea, respiratory, diseases, cardiovascular diseases
Energy for cooking/food storage	Indoor pollution, food security	Diarrhea, anemia, malnutrition

2.2. Diseases with the highest child mortality rate and dwelling/ environmental categories

According to the WHO report (WHO,2019), the diseases with the highest mortality rate in the zero to five years old population all over the world are Neonatal complications/disorders, Low Respiratory Infections (LRI), Diarrhea, Malaria, and Protein-energy malnutrition/anemia (PEM). These five diseases were selected to investigate the possible link with unhealthy dwelling in the available literature. Through a scoping review, each disease was linked to a specific housing associated factor.

The review was conducted considering only children (<5 years of age) living in slums, as older ages and living in developed or rural areas may be differently associated with the selected diseases. The selection by title excluded reviews of previous papers or anthropologic analysis of developing countries. Selection by abstract excluded publications not related to

the specific link investigated. However, when the number of selected studies was too small, synonyms of the search words were added with the aim of maximizing the number of included publications. Findings were considered relevant only if confirmed by three or more papers, for the same reasons explained in the previous paragraph.

Table 2.2 – Examples of links between dwelling/environmental categories and risk of acquiring diseases

	Urban services	Drinking water	Sanit ation	Energy for cooking	Heating	Ventila tion	Refuse disposal	Adequate space	Prote ction
LRI	x	x	x	x		x	x	x	x
Diarrhea	x	x	x	x			x	x	x
Malaria	x	x	x			x			x
Neonat. Complic.	x	x		x	x		x		
PEM	x	x	x	x					

2.3. Focus on every disease: defining parameters impacting on child health for each dwelling and environmental feature

Starting from papers selected in the previous step, all the specific associated dwelling and environmental features found in those studies were listed (e.g. respiratory diseases linked to ventilation in terms of the adequate number of windows, indoor air quality or availability of fans). The first step was the research on different databases of the name of one of the diseases AND an associated dwelling and environmental feature. Inclusion criteria were publication date less than 20 years ago and focused on children (age 0-5 years). Selection by abstract was based on the mention of Odds Ratios (OR) in the text, as an association of the considered diseases with the considered dwelling feature variable. Indeed, the OR was used as a quantitative value to elaborate a ranking scale. At least three studies had to convey on the association (OR>1 or OR<1). It was not possible to find an OR for some combinations of disease and dwelling feature. Moreover, the research showed a huge deficiency of literature focused on children in slums. To avoid these problems, the systematic review was repeated, extending population to any range of age and any location. To validate and include these findings, experts from the Infectious Diseases Department of the Italian National Institute of Health were consulted. If it was still not possible to find robust evidence of significant ORs, the association between the considered parameter was elaborated through a proxy variable or excluded.

3. Development of the tool: ranking scale and final layout

Associated dwelling and environmental feature were transformed in questions that will compose a questionnaire. For each parameter defined in the previous step, connected to every single disease, an OR=1 was assigned to the variable that represents the “baseline scenario”. According to the literature review, an OR was assigned to the other possible exposures. Once a variable/exposure has been selected according to a case study, a partial final score is defined for the single illness summing the ORs resulting from the questionnaire, on a 0-10 ranking scale. To standardize the final values of each disease, a partial raking scale was defined:

- The minimum sum of ORs is the 0 of the scale (Low mortality risk) : best-case scenario
- The maximum sum of ORs is 10 (High mortality risk): worst-case scenario

As visual communication is important, the result is given on a colored scale:

The tool aims at being applied in any country; therefore, a specific parameter related to location was considered. The implemented solution is to multiply the score of the single disease by the child mortality percentage of that specific disease in the considered country, available from databases like IHME (https://vizhub..healthdata.org/gbd-compare/). However, there can be aleatory variables (e.g. altitude, cultural behaviours, casualties) straying the local mortality from the general one of the country, so the mortality of the disease in the specific area has to be selected: Much higher, Higher, Similar, Lower or Non-existent compared to the country, associated to amplifying or reducing coefficients.
The total final mortality risk score (R) of the house due to all the diseases is a weighted average customized for the specific location:

$$R = \frac{\sum (\text{Risk of each disease} \times \text{Country mortality \%} \times \text{Local mortality coefficient})}{\text{Number of the diseases}}$$

This total risk score R is standardized to have a final value (Rf) in a 0 to 10 scale, again based on the best- and worst-case scenarios: 0-4 is Low risk, 5-7 is Medium risk, 8-10 is High risk.

3.1. Comments

It was not possible to find ORs for two malaria parameters, so a proxy was introduced: a proxy is an indirect measure of an outcome to which is strongly correlated, even if it is less accurate than the OR. A value associated with the reduction of the entrance of mosquitoes is available from the literature, so it replaced the OR considering a direct relation between mortality and the presence of mosquitoes in a room. For future implementations, when ORs are not available, the use of a proxy is an acceptable alternative. Furthermore, available ORs are often related to studies conducted in specific countries, so not applicable in a tool that aims to be used worldwide. It would be suggested to find or calculate an average OR: the intention is to have specific ORs at a country level, entered automatically in the tool.

4. Case study: test and results

The developed tool was tested on a data set from a previous study that monitored indoor environmental parameters and surveyed community members (Nix, 2020): 25 houses in the resettlement colony of Savda Ghevra, in the North-West area of Delhi (India). People were moved here from the city, to form a new slum area and independently build their houses. Low-income families built cheap and unhealthy houses. Dwellings vary from one storey to multiple-storeys; construction materials range from bamboo to concrete. Many houses do not have windows, others have air conditioning systems, but all of them have electric fans, due to the high temperatures that can be reached in New Delhi. Drinking water is brought by tankers and storage at home. Fifteen houses among 25 have toilets inside, but there is no piped water: water is poured to form collection as there is no net joining public sewer system. The most common cooking fuel used is Liquefied petroleum gas (LPG). Wood is used for heating, increasing the risk of fire. The assessed houses were categorized depending on structural characteristics: “Kutcha” houses are characterized by walls and roof made of materials such as plastic sheet and bamboo, dirt floors and not stable structure (Nix, 2020); “Pucca” house are instead made of more resistant materials, like bricks and stone, but the supporting structure is not always reinforced.

Data collected on each house were put in the tool, to analyze the resulting scores and the feasibility of the questionnaire. According to the results, 21 of 25 houses are assessed

with a final “low risk” score (0-4); one is a medium risk (5-7) (Table 4.1), and only three houses are highly risky (8-10). The most impacting parameters emerged to be the type of fuel used for cooking and heating, the presence or absence of the refrigerator, and the number of children living in the house, related to overcrowding. Suggested interventions should prioritize implementations in houses with a “high risk” score for Neonatal disorders, as it is the disease with the highest mortality rate in India. LPG should be used as the main fuel in all houses, to minimize the impact of the disease that threatens children the most in this specific location. Other implementations are providing houses with a cooler and education to parents and children on better levels of hygiene.

Table 4.1 – Results of the risk: number of houses associated with every disease

Risk	Neonatal complications	Respiratory diseases	Diarrhea	Malaria	PEM/Anemia	Final Score
Low risk (0-4)	22	18	15	25	8	21
Medium risk (5-7)	0	7	9	0	11	1
High risk (8-10)	3	0	1	0	6	3
Mean score	1	4	4	2	6	3

A comparison of the general trend of child mortality (0-5 y/o) in India with other developing countries in which slums and informal settlements are diffused confirmed that the “low risk” range common to the 25 tested house is a robust result that reflects the real situation in the considered country. The tool and obtained scores are proved to be reliable.

5. Discussion and limitations

The tool presented here is the first experiment aimed at easily scoring the health risk of dwellings for children aged 0-5 years living in slums. It is based on a questionnaire built to be easily usable and quick to compile, no specific or technical, as no highly trained personnel is needed. Moreover, the tool shows the critical areas related to the most impacting diseases, in order to prioritize and plan interventions that improve specific aspects: the scores (total and by disease) obtained provide synthetic and valuable information to establish urgent interventions.

An issue associated to the impact of considering mortality rates was outlined by testing the tool, regarding the Neonatal complications/disorders: the tool presents only one question on fuel type, as it is the only house factor proved to be correlated with neonatal disorders by epidemiologic evidence (WHO, 2005). The literature review outlined a strong correlation between other environmental and occupational factors and neonatal complications/disorders, but there is no specific epidemiologic evidence (Rahman, 2011). The score of the house associated with Neonatal complications relies only on one parameter, determining no intermediate scores between 0 and 10. One single parameter has a massive impact on the general evaluation, unbalancing the final result. It is hoped that future epidemiological evidence will populate the list of dwelling’s factors involved.

Another advantage of the presented tool is that data collected is intended to be entered in a tailored platform. This will allow a rapid recording of information, a check on the data entered, a quick elaboration of risk values by disease and overall, and a periodical update of mortality data according to international publications.

A constantly updated database of the available papers on the link between diseases and dwelling’s features would help improving the tool accuracy, and the expansion of the selected diseases is advisable according to local epidemiology.

6. Conclusions

Conditions in slums are associated with poor housing and unhealthy conditions (Ezeh, 2017), increasing the negative impact on the health of children. Governments should provide adequate policies, as fundamental steps to protect children and contribute to social equality, starting from improvements in existing housing. To this aim, there is the need to take into account a house as a single case and assess whether it is "good" or "bad" in relation to child health.

The tool presented in this study intends to respond to these needs: it assigns a score to a considered dwelling in slums, evaluating the impact on children in association with the five diseases with the highest mortality rate on infants (age 0-5 years). The relevance of this tool is related to the lack of assessing instruments focused both on children and slums. The reliability of the tool was confirmed by testing it on a dataset of houses located in the resettlement colony in Delhi (Nix,2020).

The approach exposed is flexible and can be applied to other diseases and implemented with new parameters. As people's lifestyle and habits change all over the world, also house environment will modify its impact on people's health. This tool represents an easy-to-use approach that can dynamically follow innovation both in buildings and health to guarantee human dignity, achieve sustainable development, and reduce social inequalities.

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