Original article

Crowding in a traditional rural housing ("Tukul") in Ethiopia

Abera Kumie[1], Yemane Berhane[2]

Abstract

Background: Poor housing condition is one of the major public health concerns in many developing nations due to its association with the health status.

Objectives: To determine the size of traditional "Tukul" by altitudinal zone in rural communities.

Methods: During a census enumeration 5113 rural housing units were physically assessed. Axis, radius, and wall height were measured to the nearest centimeter by trained enumerators using a tape meter.

Results: The mean (±SD) values of axis, radius, and wall height were found to be as 537.92cm (±84.88), 329.43cm (±64.81), and 236.38cm (±22.65), respectively. The mean (±SD) space for floor area was 35.43 (13.72)m^2 and space by indoor volume was 123.42 (60.26)m^3 per habitable "Tukul". According to the WHO literatures for a dwelling units, about 85% of the "Tukuls" in a rural area are crowded and far behind to satisfy the physiological needs of a resident. Nearly 95% of housing units had only one room.

Conclusions and Recommendations: The high magnitude of overcrowding in rural housing units indicates the poor living and sanitation conditions. As this predisposes to many adverse health conditions, appropriate interventions need to be done with out delay. [*Ethiop.J.Health Dev.* 2002;16(3):303-308]

Introduction

Housing conditions have major public health importance. Healthful housing is one that satisfies the basic physiological and psycho-social needs of human beings and do not expose to environmental hazards (1). The World Bank estimates that over 50% of the third world population live in conditions of extreme poverty and that nearly one quarter of the worlds population live in shelters that do not satisfy the basic needs of housing (2-4). The usual practice for measuring of crowding at household level is to determine the number of persons per room and space availability in terms of floor area per person. Their threshold values were derived on the basis of physiological needs of health standards for dwellings (5). WHO literatures often suggest a 9-10m^2 floor area per person and a minimum ratio of 0.10 of window to floor area to provide adequate natural ventilations (6-8).

According to the National Population and Housing Census in 1984, 39.0% of urban and 52% of the rural population live in an overcrowded housing (9). In Ethiopia, basic housing needs such as safe water and sanitation have low coverages in the majority of housing units in rural population representing 14.8% and 5.91% coverages, respectively (10), presenting favorable environment for the transmission of various types of communicable diseases. In adequate in-house space has been identified as a risk factor for the propagation of respiratory infections due to bacterial causes and indoor air Pollution. A high risk of acute lower respiratory infection was associated with increasing number of persons per room and high level of indoor air pollution in a study

[1]Addis Ababa University, Medical Faculty, Department of Community Health; [2]Addis Ababa University, P.O.Box 9086, Addis Ababa, Ethiopia, Fax:+251-1-517701; Tel: +251-1-513715

made among under five children in Addis Ababa (11).

In Ethiopia about 86% of the population live in rural areas in a traditional hut called "Tukul". Measurement of "Tukul" size , however, has never been made. The purpose of this study was to determine the average size of a traditional "Tukul" in order to generate a crude reference data for the assessment of health effects of crowding.

Methods

The study was conducted in the Butajira Rural Health Program (BRHP) study sites that are located in Meskan and Mareko district some 130 Kms from the capital city of Addis Ababa. The area consists of two altitudinal zones, lowland and highland (12). Data were collected during the 1999 **Census** of the BRHP in its all study sites consisting of nine villages and one urban site. The study area is mainly predominated by "Gurage" ethnic group, which is further divided into minor dialectics. The census for this study is referred to the measurement of all "Tukuls" size inhabited by a house hold in the nine rural areas. The data collectors and supervisors were staffs of BRHP, who had completed 10th grade. The supervisors checked completeness and consistency of the data on daily basis.

The main variables were axis, radius, wall height, and altitude. Radius and wall height were measured in centimeters in three digits before decimal using a tape measure. While the axis measurement, because of its inaccessibility to one of its end point by an enumerator with a tape meter, was first gauged by a long straight stick and then labeled with a tape measure. **Axis** locally known as "Misseso" is a wooden standing post that originates from the floor centre of the "Tukul" and extends to the centre of the thatched roof. Axis serves as a framework for the support of lateral extensions of the roof. **Radius** is just half of the diameter of the floor of the "Tukul". These dimensions define the size of "Tukuls" in terms of area and air volume. The BRHP study site was divided into rural lowlands and highlands on the basis of geographic and social conditions. **Rural Altitudinal zone** is dichotomized into "Kola", meaning lowland generally below 2000 meters, and "Dega", meaning highland above 2000 meters of the seal level in reference to previous studies (13-14).

"**Tukul**" is a traditional thatched roof hut found in rural settings of Ethiopia. It is basically with a circular floor and wall, and conical shaped roof. Any type of available wood, euclaptus planks commonly, is used for the wall construction and roof support. The wall is reinforced with crop stocks, mainly maize and sorghum, and is usually plastered with mud mortar some times mixed with ash and fresh cow dung for the second coating. Lighter materials, like grass and bamboo combined with thin wood planks are preferred for roof construction. The floor is plain earth and simply puddled with mud. Grasses are used for thatching.

Crowding index this index is used to define the relative availability of a space in terms of area, indoor air volume, and number of "rooms" in a given "Tukul" for a household. The UN approach for defining crowding index in terms of persons per room was referred (10) and modified for estimating the housing needs by persons per room, area, and volume of the "Tukul" for this study. This index in terms of number of persons per habitable room were categorized: 1 person/room as under crowded; ≥ 2.0 persons/room as crowded; by floor area:<25m^2 as severely crowded, 25-49.5m^2 as adequately crowded, and ≥ 50.0m^2 as under crowded. The corresponding indoor air volume was indexed as: <79m^3 severely crowded, 79.0 - 184m^3 as adequately crowded , >185m^3 as under crowded.

The "Tukul" floor space is assumed to be equivalent to one room if it is not partitioned for various household purposes. A 10m^2 floor area per person is assumed to be adequate for the satisfaction of a physiological needs of a resident using a space in a housing unit and that for an average house hold size of 5.0, the space requirement by floor area is 50m^2 per family.

Data entry for radius, axis, wall height and other census variables was made on a DBASE

software. The data for analysis was exported into EPI INFO version 6 statistical package, that is also used for data cleaning. Frequency summary distributions, measures of central tendency and proportions were used to describe the data. Chi-square and t-test were applied for test of statistical significance.

Results

A total of 5113 housing units were measured, 55.62% in highlands and 44.38% in lowlands. The mean (±SD) values of axis, radius, and wall height are represented as 537.92cm (±84.880), 329.43cm (±64.806), and 236.38cm (±22.648), respectively. The mean values of axis, radius, and height of "Tukuls" in the highland are found to be significantly ($p<0.001$ for both types of altitude) larger than their respective counter dimensions in that of lowland (Table 1).

Table 1: **Distribution of the mean values of "Tukul" dimensions by altitude, Butajira, Ethiopia 1999.**

Villages by altitude	Number of study "Tukuls"	*Mean (SD) values, in cm*		
		Axis	Radius	Wall height
Total	5113	537.9(84.88)	329.4(64.8)	236.4(22.6)
Villages in high land	2844	556.5(87.1)	338.2(63.3)	237.9(22.2)
Villages in low land	2269	414(75.9)	318.5(64.9)	234.5(23.0)
Test of significance for mean values of axis, radius, and height by altitude	t=18.08, P<0.001	P<0.001		P<0.001

Space availability

Area and volume of the "Tukul" were calculated using standard equations: pr^2 and $(pr^2h + pr^2 (a-h)/3)$, respectively, where "r" is radius, "h" is wall height, "a" is axis and "(a-h)" is the altitude (length) used to calculate for the cone volume of the "Tukul". The overall mean (±SD) values were found to be 35.43 (13.72)m^2 and 123.42 (60.26)m^3 per "Tukul" for area and volume, respectively. Both area and volume are significantly different between highland and lowland "Tukuls" (t=10.47 for area, t=11.84 for volume, $p<0.001$) (Table 2). The proportion of "Tukuls" that are with high rate of overcrowding based on the floor area in the highland is less than that of in the lowland (X^2 =47.02, $p<0.001$). Similar significant difference was found when comparing volume by altitude and that the rate of under occupancy in the highland is nearly twice that of in the lowland ($p<0.001$). The relative distribution of the space in terms of overcrowding categories is indicated in Table 3.

Nearly 95% of all "Tukuls" has just one room with out any partition. The proportion of partitioned houses is more likely to be found in the highland as compared to that of in the lowland. Of all study units, 82.9%, 89.9%, 95.3% did not have window, separate kitchen, and latrine, respectively. The mean (SD) family size per household was 4.95 (2.14).

Table 2: **The distribution of "Tukuls" area and indoor air volume by altitude, Butajira, Ethiopia, 1999.**

Village by altitude	Number of study units ("Tukuls")	Mean values (SD)		Median values	
		Area, m^2	Indoor volume, m^3	Area, m^2	Volume, m^3
Total	5113	35.43(13.72)	123.42(60.26)	34.2	114.00

Villages in high land	2844	37.20(13.79)	132.21(62.66)	35.7	121.40
Villages in low land	2269	33.20(13.30)	112.40(55.17)	32.0	104.10

Test of significance of mean values of area and volume by altitude: t=10.47, p<0.001 and t=11.84, p<0.001, respectively. The distribution by area and volume was approximately symmetrical.

Table 3: **The distribution of housing space availability by altitude in Butajira, Ethiopia, 1999**

Characteristics (Variables)	Climatic condition			X^2	P-value
	Highland (n=2844) Number (%)	Lowland (n=2269) Number (%)	Total (n=5113) Number (%)		
By floor area					
Severely crowded	571(20.1)	684(30.1)	1255(24.5)		
Adequately crowded	1763(62.0)	1334(58.8)	3097(60.6)		
Under crowded	510(17.9)	251(11.1)	761(14.9)	94.28	P<0.001
By volume					
Severely crowded	566(19.9)	714(31.5)	1280(25.0)		
Adequately crowded	1781(62.6)	1342(59.1)	3123(61.1)		
Under crowded	497(17.5)	213(9.4)	710(13.9)	129.4	P<0.001

Discussion

The crowding status in this study is determined by the triplets of axis, radius and wall height of a "Tukul". These dimensions are used to measure crowding in terms of floor area and "Tukul" indoor volume. If a cut off 10 m^2 per person is taken as a guideline weighted mean value for a good housing (5-8,15-17), then the proportion of "Tukuls" not satisfying this requirement is 85.12% for an average house hold size of five per "Tukul" among the study population. This proportion is more pronounced by considering overcrowding by number of rooms, representing that 95% of all "Tukuls" has just one room . The increased overcrowding trend is consistent with housing needs evaluations done in developing countries (3). Such housing conditions is believed to support the transmission of a variety of communicable diseases to their level of endemicity causing high childhood mortality (18,19). Lack of basic sanitary facilities and poverty, that are prevalent in the study area, in addition to the overwhelming overcrowding condition, contribute much for the sustenance of these conditions (12, 20-23).

The mean values of area and indoor volume were higher in highland than that of in the lowland. The availability of euclaptus trees required for the construction of "Tukuls" and the presence of "Enset", a false banana used for the preparation of a staple food known as "Kocho" in the highland could be some of the possible explanations for the larger sizes of "Tukuls" in these areas. These geographically limited materials are mainly found in the highland areas and they can be assumed proxies of better income. The favorable hot climate for termites, a wood pest, breeding could be one possible factor that might discourage the construction of bigger "Tukuls" in the lowland. In general the axis of "Tukuls" in the highland are significantly raised over the wall height making a relatively narrower angle of the roof from the inside as compared to the flattening trend of the roof with wider angle in the lowland. The higher the axis, the higher the "Tukul" volume tends to be, the larger will be the space pocket under the cone of the roof which implies better space reserve for air pollutants to accommodate. This helps to minimize relatively the amount of smoke and its residence time in the breathing zone of

residents, consequently decreasing the risk of exposure to smoke during cooking activities. This assumes the participation of total indoor air volume in reference to the indoor ventilation system (24).

The fact that a significant proportion of population resides in an overcrowding housing units, and this magnitude being worse in the lowland, a housing factor can be considered as one element associated with the existing high morbidity and mortality by altitude among children of under five (11,18,25). Excess under five mortality in the lowland was documented when compared to that of in the high land (18).

In summary the poor housing condition in the study area is posing a health risk for the transmission of a wide variety of communicable diseases and pathologies related to indoor air pollution. The study has also indicated the feasibility of generating reliable and objective information for measuring crowding level in a rural household based on sample measurements of housing units instead of relying on measuring number of persons per room, which does not tell much about its size. Improving the housing condition of "Tukuls" through public education, by way of advocating for more space and creating windows during construction, is recommended. Introducing an appropriate healthful housing design in a pilot or demonstration sites along with public education can further facilitate the improvement of housing environment. Further studies are needed to determine differences in crowding among different socio-cultural and environmental conditions.

Acknowledgments

We would like to acknowledge the Butajira Rural Health Program for providing the necessary resources for the study. The Department of Community Health of the Medical Faculty of Addis Ababa University is greatly thanked for the encouragement to undertake the study.

References

1. World Health Organization. Appraisal of the hygiene quality of housing and environment. WHO Technical report series.1967;353.
2. World Bank. World Development report of 1990. World Bank, 1990: 1-2, 28-29.
3. World Health Organization. Our planet, our health, report of the WHO commission on health and environment. Geneva: WHO, pp197-208.
4. World Health Organization. Towards decent housing for all. WHO Health Forum, 1988;9(3):353-356.
5. Goromosov MS. The physiological basis of health standards for dwelling. World Health Organization, Public health papers 1968;(33):40-45.
6. Yash Pal Bedi. A hand book of preventive and social medicine. Ananad Publishing Co., New Delhi, 1980: 89-91.
7. Andrzejwski A Berjusov KG, Ganewatte P and et al. Housing Programmes: the role of public health agencies. Geneva, WHO, Public Health Papers 1964(25):97-102.
8. Hussain SK. Water supply and sanitary Engineering. 2nd edition. Oxford and IBH Publishing Co., New Delhi, 1984:765-766.
9. The Transitional Government of Ethiopia, Office of Population and Housing Census Commission, Central Statistical Authority. The 1984 Population and Housing Census of Ethiopia, Analytical report at national level, Addis Ababa, 1991:340-353.
10. Federal Democratic Republic of Ethiopia, Office of Population and Housing Census Commission, Central Statistical Authority. The 1994 Population and Housing Census of Ethiopia, Results at Country Level, Volume II Analytical report. June 1999, Addis Ababa.
11. Kebede D. Socio-demographic characteristics and indoor air pollution as risk factors for acute lower respiratory infections in under five children in Addis Ababa Ethiopia. The Ethiopian Journal of

Health Development, 1997;11(special issue):315-323.

12. Berhane Y, Wall S, Kebede D, et al. Establishing an epidemiological field laboratory in rural areas - potential for public health research and interventions: the Butajira Rural, Health Programme 1987-1999. The Ethiopian Journal of Health Development, 1999;13(special issue):4-8, 20-23.
13. Muhe L. Child Health and acute respiratory infections in Ethiopia: Epidemiology for prevention and control. A Thesis work background: 1994:5.
14. Shamebo D, Muhe L, Sandstrom A. The Butajira Project in Ethiopia: Mortality pattern of under fives. The Ethiopian Journal of Health Development, 1994;8(special issue):255.
15. Vidya Ratan. Handbook of Preventive and Social Medicine. Jaypee Brothers, Medical Publishers, 10. New Delhi, 1986:55-59.
16. Davies GG. Clay's Public Health Inspector's Handbook. 12th edition, HK Lewis & Co.Ltd., London, 1968:642-650.
17. Joseph A. Salvato. Environmental Engineering and Sanitation. Fourth edition, Wiley-Inter science Publication, New York, 1992:1169-1174.
18. Shamebo D, Sandstrom A, Muhe L,Freij L., Krantz I., Lonnberg G., Stig W. The Butajira Project in Ethiopia: a nested case-referent study of under-five mortality and its public health determinants. The Ethiopian Journal of Health Development, 1994;8(special issue):389-394.
19. Muhe L, Frij L, Byass P, Anita S, Wall S. A one year community study of under fives in rural Ethiopia: public health determinants of morbidity. Ethiopian Journal of Health Development, 1997;11(special issue):369-375.
20. Martin AE (editor). Health aspects on human settlement: a review based on technical discussions held during the 39th World Health Assembly. World Health Orga-nization, Public health papers 1976:(66)22-23, 29-31, 50-51.
21. World Health Organization. Uses of epidemiology in housing programmes and planning human settlement. WHO Technical report series. 1967;(353).
22. World Health Organization. Urbanization and its implication for child health- a potential for action. WHO, Geneva, 1988:33-34.
23. World Health Organization. Improving environmental health conditions in low income settlements- A community based approach to identifying needs and priorities. WHO offset publication, 1987;(100):4-9.
24. American Conference of Governmental Industrial Hygienists. Industrial ventilation: a manual of recommended practice. 20th edition, Ciccinati, 1988:2.2-2.6.
25. Muhe L, Frij L, Byass P, Anita S, Wall S. A one year community study of under fives in rural Ethiopia: patterns of morbidity. Ethiopian Journal of Health Development, 1997;11(special issue):361-367.