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Adequacy of Amount of Light for Performance of Selected Tasks in Selected Households in Ludhiana

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ABSTRACT The present study was carried out in *Punjab* with the objective to survey the existing lighting conditions, to determine the light intensity in different rooms and to determine adequacy of amount of light (level of illumination) for the performance of selected tasks in the selected households. Sixty households each from two localities i.e. approved (*Sarabha Nagar*) and unapproved (*Haibowal*) were randomly selected for the present study. Light intensity in selected parts of house and work areas was measured to determine adequacy of amount of light. Results revealed that openings on outer walls were less than one fourth of wall area in both localities. In unapproved locality provision of skylight was found more. Fluorescent tubes and incandescent bulbs were more frequently used in both the localities and compact fluorescent lamps, halogen lamps, chandeliers and ceiling lights was found to be very limited. Entrance of selected houses of both localities received maximum sunlight. Lobby and storeroom received minimum sunlight. Assessed daylight was found to be maximum in entrance in both localities. Assessed light from fluorescent tube was observed to be higher as compared to incandescent bulb in all areas of both localities. Non significant difference was found between objective and subjective assessment of light intensity with and without artificial light except for lobby and kitchen. Comparison with recommended values of light intensity revealed that in social zone, light intensity was more than recommended and in private zone it was less than recommendations given by National Building Code of India, 2002. Mean observed value for light intensity was found to be highest for writing i.e. 206.27 lux and 181.67 lux and lowest for ironing i.e. 134.92 lux and 124.50 lux from approved and unapproved locality respectively. Task related lighting for all the activities was also found to be much less in intensity than recommended values in both the localities.

INTRODUCTION

For doing appropriate work, adequate light is necessary to assist perception of task detail. When work is done requiring considerable usual effort, higher reflective values may to desirable (Kasu, 1995) There should be adequate light around the work areas in the home so that we can perform the various activities without straining our eyes and also ensuring a check on our energy expenditure (physical, mental and temporal) (Hopkinson, 1970). It is important to have optimum illumination (nor a glare, neither poorly lit) for smooth functioning in home interiors. A fully functional lighting is that which fulfils the need for natural right. Improper lighting results in many kinds of health problems like headache, eye strain etc. (Grandjean, 1973). There is a definite need to conduct researches on lighting practices in the homes - the places where we spend a greater part of our lives. Therefore, the present study is undertaken with the following objectives:

1. To survey the existing lighting conditions in the selected households.
2. To determine the light – intensity in different rooms of the selected households.
3. To determine adequacy of amount of light (level of illumination) for the performance of selected tasks in the specific work areas in the selected households.

METHODOLOGY

The data for the present study was collected from 120 randomly selected respondents comprising 60 residents from Sarabha Nagar (Approved by improvement trust of Ludhiana) and 60 from Haibowal (Unapproved by improvement trust of Ludhiana) in 2002. Information regarding openings of the house and lighting sources was gathered using observation technique. Light intensity in different zones (social and private and activity zones) and for specific task lighting was measured using lux meter. The observed values were compared with recommended values to determine the adequacy of amount of light for the performance of selected tasks and in selected zones of selected houses. To analyze the data Chi square test was used to test the association of parameters between approved and unapproved locality. Difference in proportion test was used to test the

significance of differences between the parameters.

RESULTS AND DISCUSSIONS

Existing Lighting Conditions in Observed Houses: Most houses from both localities had provision of lawn and had open area less than one fourth of constructed area. The area covered by windows, doors and ventilators on outer walls was also less than one fourth of wall area in both the localities. In unapproved locality provision of skylight was more as compared to approved locality which were mostly placed in the lobby area. Provision of fluorescent tubes which was mostly one in number for each zone was seen to be less in unapproved locality, the wattage of which was also very low (20-40 watts) in all the social, private and utility zones. The trend of using fluorescent tubes was higher in approved localities whereas wattage used was still minimum i.e. 40. The usage of incandescent bulbs was restricted to one in each room in both the localities and wattages preferred in these bulbs were 60. Use of CFL, lamps, halogen lamps and ceiling light was limited mostly to approved locality particularly in lobby, entrance, bedroom and storeroom. Entrance in both the localities received maximum sunlight during whole day in both summer and winters whereas kitchens in both the localities received plenty of sunrays in morning hours. But it was bathroom which received maximum sunrays for rest of day particularly in unapproved locality during both summer and winter. Minimum light was observed in lobby and storeroom in both the localities (specially in unapproved locality) in all parts of day during both seasons. However, stairs in unapproved locality received more sunrays.

In both the localities assessed natural light was highest in entrance and kitchen followed by other social, private and activity zones. However, living room and lobby in unapproved locality received more natural light than these areas in approved locality. Assessed light from artificial sources was observed to be higher with the provision of fluorescent tubes as compared to incandescent bulbs in social, private and activity zones of both the localities.

Light Intensity in Social Zone without Artificial Light: It can be seen from Table 1 that in both the localities maximum light intensity without artificial light was observed in entrance (mean value 1346.5 and 1125.5 lux from approved and unapproved locality respectively) followed by stairs with average value 461.16 lux from approved and 782.67 lux from unapproved locality. In approved locality minimum light intensity without artificial light was seen in living room with average value 188.17 lux and in unapproved locality minimum light intensity without artificial light was observed in lobby with mean 133.95 lux.

To determine the adequacy of amount of light (level of illumination) in public zones of selected houses, mean observed value of light intensity were also compared by mean recommended values as given by National Building Code of India 2002. Table 1 illustrates that mean recommended light intensity for entrance is 475 lux and mean observed light intensity (without artificial light) was 1346.50 lux and 1125.50 lux for approved and unapproved locality respectively which was 283.47 percent and 239.94 percent of recommendations for approved and unapproved locality respectively. It can further be seen in table that mean observed light intensity in stairs in both the localities (461.16 lux from approved and 182.67 lux from unapproved locality) was 249 and 486.41 percent of mean recommended value in approved and unapproved locality respectively considering the fact that recommended mean light intensity for stairs is 185 lux the observed light intensity is 3 to 5 times higher than it. Since stairs were alighting from outside the house, in unapproved locality, the area was twice well lit as compared to light around stairs in approved locality. The mean recommended light intensity for living rooms in 185 lux whereas mean observed light intensity was 188.17 lux and 137.66 lux for approved and unapproved locality respectively. This value was 101 and 74 percent of the recommendation for both approved and unapproved locality respectively. It was also observed in table that mean observed light intensity for lobby was 201.25 lux in approved locality and 133.95 lux for unapproved locality which was found to be 134 and 89 percent of recommended value (150 lux) in approved and unapproved locality respectively. Living rooms and lobby in unapproved locality were poorly lit as per the recommendations.

Light Intensity in Social Zone with Artificial Light: Table 1 depicts that in both the localities maximum light intensity with artificial light was observed in entrance (1091.25 lux for approved

and 1480.50 lux for unapproved locality respectively) followed by stairs with 486.41 lux from planed and 864.25 lux from unapproved locality whereas in both the localities minimum light intensity with artificial light was found in living room with average value 202.50 lux from approved and 187.17 lux from unapproved locality.

Light intensity in these areas was also compared with mean recommended value given by National Building code of India, 2002; to overview the adequacy of observed light intensity in private and activity areas. Table further revealed that mean recommended light intensity for entrance is 475 lux and mean observed light intensity was 1480.50 lux and 1091.25 lux for approved and unapproved locality respectively which was 311.68 percent and 229.68 percent of the recommendations for approved and unapproved locality respectively. Mean recommended light intensity for stairs is 185 lux and mean observed light intensity (with artificial light) was 486.41 lux and 864.25 lux for approved and unapproved locality respectively. This value was 262 and 467 percent of the recommendation for approved and unapproved locality respectively. Stairs in unapproved locality were almost twice well lit than stairs in approved locality. Mean observed light intensity for living room was 202.50 lux and 187.16 lux for approved and unapproved locality respectively which was found to be 109 and 101 percent of recommended value (185 lux) in approved and unapproved locality respectively which meant that living room in both the localities had recommended light intensity. Table further revealed that mean recommended value of light intensity for lobby is 150 lux whereas mean observed light intensity was 236.33 lux and 202 lux for approved and unapproved locality respectively. However this value was 157 and 134 percent of recommendation for both localities that is fairly above recommendations.

It was found that light intensity with and without artificial light was better in approved locality as compared to unapproved locality in social zone except stairs. Reasons may be that in approved locality every house was properly constructed according to building by laws and supervised by architects with the view for providing better lighting. Hence more openings and open sides were kept in these houses which contributed to better lighting conditions. More windows and ventilators on outer walls were provided so that maximum light can enter the house. On the other hand in unapproved locality house plans were not adhered to building by laws and were constructed without the guidance of architects. Hence most of the houses lacked sufficient openings for light and also because the locality was unapproved, sufficient open areas were not kept for letting the light in. As mostly all stairs was found to be situated outside the house of unapproved locality that is why light intensity in there stairs was more than in approved locality.

Light Intensity in Private and Activity Zones Without Artificial Light: It can be seen in Table 2 that is approved locality bedroom was the area which was found to have maximum light intensity without artificial light (average value 131.17 lux and in unapproved locality bathroom received maximum light. It may be due to the reason that most bathrooms in unapproved locality were situated outside main building. Storeroom was the area seen to have minimum light intensity without artificial light in both the localities (average value 16.83 lux from approved and 12.33 lux from unapproved locality).

In order to determine the adequacy of light intensity in private and activity zones, these values were compared with recommendations given by National Building Code of India;2002. It can be seen in the table that mean recommended light intensity for kitchen is 375 lux whereas mean observed light intensity was 121.33 lux and 109.67 lux which was only 32 and 29 percent of recommendation from approved and unapproved locality respectively. These values were just one third of recommendations at a area where women spend 75 percent of her day's time. Mean observed light intensity for bedroom was 131.10 lux and 115.3 lux which was found to be 70 and 62 percent of recommended value (185 lux) for approved and unapproved locality respectively. Mean recommended light intensity for bathroom is 250 lux and mean observed light intensity without artificial light was 115.4 lux and 133.5 lux which was 46 and 53 percent of recommendation for approved and unapproved locality respectively. Mean observed light intensity for storeroom was 16.8 lux in approved locality and 12.3 lux in unapproved locality which was found to be only 16 and 12 percent of recommended value (100 lux) in approved and unapproved locality respectively. These findings are in line

Table 1: Light intensity (lux) in social zones of selected houses

Area	*Mean recommended value#*	*Without artificial light*				*With artificial light*			
		A (n = 60)		*UA (n = 60)*		*A (n = 60)*		*UA (n = 60)*	
		Mean observed value (lux)	*% age recomm-endation*	*Mean observed value (lux)*	*% age recomm-endation*	*Mean observed value (lux)*	*% age recomm-endation*	*Mean observed value (lux)*	*% age recomm-endation*
Entrance	475	1346.50	283.47	1125.50	239.94	1480.50	311.68	1091.25	229.68
Stairs	185	461.16	249.28	782.67	432.06	486.41	262.92	864.25	467.16
Living room	185	188.17	101.71	137.66	74.41	202.50	109.46	187.16	101.17
Lobby	150	201.25	134.17	133.95	89.30	236.33	157.55	202.00	134.67

A = Approved locality
UA = Unapproved locality
# = Recommendations given by National Building Code of India Part V111, 2002

Table 2 : Light intensity (lux) in private and activity zones of selected houses.

Area	*Mean recommended value#*	*Without artificial light*				*With artificial light*			
		A (n = 60)		*UA (n = 60)*		*A (n = 60)*		*UA (n = 60)*	
		Mean observed value (lux)	*% age recomm-endation*	*Mean observed value (lux)*	*% age recomm-endation*	*Mean observed value (lux)*	*% age recomm-endation*	*Mean observed value (lux)*	*% age recomm-endation*
Kitchen	375	121.33	32.35	109.67	29.25	188.67	50.31	182.50	48.67
Bedroom	185	131.10	70.86	115.3	62.32	173.3	93.68	215.00	116.22
Bathroom	250	115.4	46.16	133.5	54.20	174.8	67.92	205.8	8232
Storeroom	100	16.8	16.80	12.3	12.3	151	151.00	81.00	81.00

A = Approved locality
UA = Unapproved locality
# = Recommendations given by National Building Code of India Part V111,2002

Table 3: Light intensity (in lux) in wok areas for performance of selected tasks in houses

	Approved locality (n = 60)			*Unapproved locality (n = 60)*			*t- value*
	Mean recommended value (lux)#	*Mean observed value (lux)*	*% age recommen-dation*	*Mean recommended value (lux)#*	*Mean observed value (lux)*	*% age recommen-dation*	
1. Writing (at the study table)	350	206.27	58	350	181.67	51	1.12^{NS}
2. Reading (leisure reading in bed)	325	173.23	53	325	154.83	47	1.99^{*}
3. Cooking (at cooking center)	375	156.77	41	375	155.42	41	1.10^{NS}
4 Dressing (at dressing table)	225	156.17	69	225	142.33	63	1.65^{NS}
5 Ironing (at board or table)	200	134.92	67	200	124.50	62	0.60^{NS}

* = Significant at 5 % level of significance
NS= non significant
# = Recommendations given by National Building Code of India Part V111,2002

with the results of the studies done by Sandhu (2001) on physiological stresses in elderly women It was thus observed that all the areas in private and activity zones in both localities were very poorly lit and were acutely deficient as per recommendations.

Light Intensity in Private and Activity Zones with Artificial Light: Table 2 illustrated that in approved locality maximum light intensity with artificial light was observed in kitchen with average value of 188.67 lux while in unapproved locality maximum light intensity was seen in bedroom with average value of 215.08 lux. However, in both the localities minimum light intensity with artificial light was observed in storeroom (average value 151.00 and 81.83 lux from approved and unapproved locality respectively). Table further depicted that mean recommended light intensity for kitchen is 375 lux whereas mean observed light intensity in kitchen with artificial light was 188.67 lux and 182.50 lux for approved and unapproved locality respectively. This value was half of recommendations i.e. 50 and 48 percent of the recommendation for approved and unapproved locality respectively. Mean observed light intensity for bedroom was 173.3 lux and 215 lux for approved and unapproved locality respectively which was found to be 93 and 116 percent of recommended value (185 lux) in approved and unapproved locality respectively. Light intensity in bedroom barely matched recommendations. Table further depicted that mean observed light intensity for bathroom was 174.8 lux and 295.8 lux for approved and unapproved locality respectively which was found to be 69 and 82 percent of recommended value (250 lux) for approved and unapproved locality respectively. Mean recommended light intensity for storeroom is 100 lux whereas mean observed light intensity was 151 lux and 81 lux for approved and unapproved locality respectively. Observed value was 151 and 81 percent of recommendation for approved and unapproved locality respectively. It was thus seen that light intensity with artificial light still was found deficient as per recommendations in private and public areas except for storeroom of approved locality and bedroom of unapproved locality.

Light Intensity in Selected Work Areas: It was clear from Table 3 that in approved locality respondents were having maximum light (206.72 lux) for writing purpose on their study table followed by leisure reading in bed, cooking food and for dressing up at dressing table (173.23, 156.33 and 156.17 lux respectively). They were having minimum light (134.92 lux) in their ironing area. On the other hand in unapproved locality light intensity for all the above activities was found to be less than approved locality. As it can be seen in the table, maximum light (181.67 lux) was seen for writing purposes in their study table. It was followed by the light in their cooking center for cooking purpose with average value of 155.42 lux which was not much different from light intensity observed for reading leisurely in bed with average value of 154.83 lux. Light intensity for dressing purpose at dressing table was assessed to be of next lower intensity (142.33 lux). Minimum intensity of light (124.50 lux) was found at ironing zone in unapproved locality.

Reasons for better lighting conditions in approved locality as compared to unapproved localities may be that probably task lights were provided in every activity area. More number of fluorescent tube lights was installed instead of incandescent bulbs in these localities. According to Illuminating Engineering Society (1987) fluorescent tube lights are much suitable for study purposes as compare to bulbs. This may be the reason for better light intensity seen in approved localities for specific tasks. The differences in task relating light intensity which were observed to be less in unapproved locality were statistically tested by applying Paired 't' test. Table 3 revealed that in spite of lower value of light intensity as seen in all selected task areas in unapproved locality, it was only for leisure reading in bed, that these differences were significant (1.99**). This may be due to provision of bed side lights in approved houses.

Adequacy of Light Intensity for Performance of Selected Tasks: To determine the adequacy of amount of light (level of illumination) for performance of selected tasks, these values were also compared by recommended values as given by National Building Code of India, 2002 which were found to be less for the performance of all activities in both localities. Observed light intensity for writing at study table was 206.27 lux (in approved locality) and 181.67 lux (in unapproved locality) which was found to be only 58.93 and 51.00 percent of the recommended mean values (350 lux) for writing purposes for approved and unapproved locality respectively which was little more than half of recommen-

dations. The mean recommended light intensity for reading leisurely in bed is 325 lux whereas the observed value of light intensity in both localities for these activities was less than the recommended value (173.23 and 154.83 lux in approved and unapproved locality respectively). This value was 53 and 47 percent of the recommendations for reading leisurely in bed in approved and unapproved locality respectively that fulfilled just half of the recommendation given. It was also seen in the table that observed light intensity for cooking at cooking center was 156.33 lux (in approved locality) and 155.42 lux (in unapproved locality) which was found to be much less (not even half the prescribed one) i.e. 41 percent of recommended mean value of 375 lux in both the localities. The mean recommended light intensity for dressing at dressing table is 225 lux whereas the observed value of light intensity in both localities for these activities was far less than the recommended value which was 156.17 and 142.33 lux in approved and unapproved locality respectively. This value was 69.00 and 63.00 percent of the recommendations for dressing at dressing table for approved and unapproved locality respectively. Table also revealed that assessed light intensity for ironing was 134.92 lux (in approved locality) and 124.50 lux (in unapproved locality) which was found to be much less i.e. 67.00 and 62.00 percent of the recommended value of 200 lux for approved and unapproved locality respectively.

CONCLUSIONS

Most houses had the open area less than one fourth of constructed area in both localities. Openings on outer walls were also less than one fourth of wall area in both the localities. In unplanned locality provision of skylight was more. Trend of using fluorescent tubes was higher in planned locality. Usage of incandescent bulbs was restricted to one in each area in both the localities and wattage preferred was 60.Use of lamps, compact fluorescent lamps, halogen lamps and ceiling lights was found to be very limited. Maximum observed light intensity (with and without artificial light) was seen in the entrance area of both the localities which was almost three times more than the recommendation. Minimum light intensity was observed in store room of unapproved locality without artificial light which was only 12 percent of recommendation. Light intensity with artificial light was still less in storeroom of unapproved locality which was 81 percent of recommended value.Non-significant differences were found in objective assessment of light intensity between approved and unapproved localities for doing selected tasks viz. writing, reading, cooking, dressing and ironing except for doing leisure reading in bed where it was found to be significantly different between approved and unapproved locality.

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