Front. Environ. Sci. Engin. China 2009, 3(2): 200–209
DOI 10.1007/s11783-009-0010-y

RESEARCH ARTICLE

Microenvironmental time-activity patterns in Chongqing, China

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Abstract An investigation using recall questionnaires was conducted in winter and autumn 2006 to evaluate the time-activity patterns in Chongqing, China. The average time spent in seven microenvironments (MEs) including outdoors, transit, living room, bedroom, kitchen, classroom/office, and other indoors were found to be about 3.5, 1.1, 2.5, 9.7, 1.4, 4.2, and 1.7 h per day, respectively. According to the results of a nonparametric test, the sampling period and day of week were significant for the variation of the time spent in all MEs except for transit and outdoors. The time budget was analyzed using a general linear model (GLM), which exhibited significant variability by demographic factors such as gender, age, residence, education, and household income.

Keywords time-activity patterns, microenvironment, general linear model (GLM), Chongqing, China

1 Introduction

Time-activity information is often used to compare and interpret the observed exposure results in a direct monitoring study [1–3], and can also be combined with microenvironmental concentrations in indirect exposure models [4,5]. Although several methods including focus groups, surveys, questionnaires and interviews, diaries and personal data loggers, direct observations, and videography can be used to gather information on time-activity patterns [6], the recall questionnaire has been generally accepted in developed countries [2,7,8]. Data on time-activity patterns for Chinese individuals are scarce although rough investigations have been conducted [9,10]. Furthermore, in China there are few studies combining demographic covariate analysis with statistical modeling. To provide data on microenvironmental time-activity patterns and their relationship with demographic factors, which is important for human exposure assessment, this study conducted a detailed statistical analysis on the microenvironmental time budgets in Chongqing, one of the four municipalities directly under the central government in China. An important motivation for our study is to establish data that are needed to better assess the relative contribution of indoor air pollution and outdoor air pollution to total population exposure in China. According to the World Health Organization, indoor air pollution is a larger contributor to premature deaths in China than ambient urban air pollution is [11]. The current study aims to provide data that can be applied in refining such estimates, thus improving the basis for public health policies.

2 Materials and methods

2.1 Participant recruitment and questionnaire sampling

Chongqing, a major metropolis in southwest China, is located at north latitude 28°10′–32°13′ and east longitude 105°11′–110°11′. As a large commercial and industrial center covering an area of 8.2×10^4 km^2, the municipality of Chongqing includes 9 urban districts (the so-called city zone) and 31 counties, as shown in Fig. 1. In this study, Shapingba (SPB) district, Jiulongpo (JLP) district, Yongchuan (YC) county, and Dianjiang (DJ) county were selected as the locations for our investigation.

The time-activity investigation was conducted using the recall questionnaire method for two sampling periods. Period 1 corresponded to January–March 2006, and period 2 corresponded to October–December 2006. The questionnaires were sent to 569 households. Study participants

Received August 2, 2008; accepted November 26, 2008

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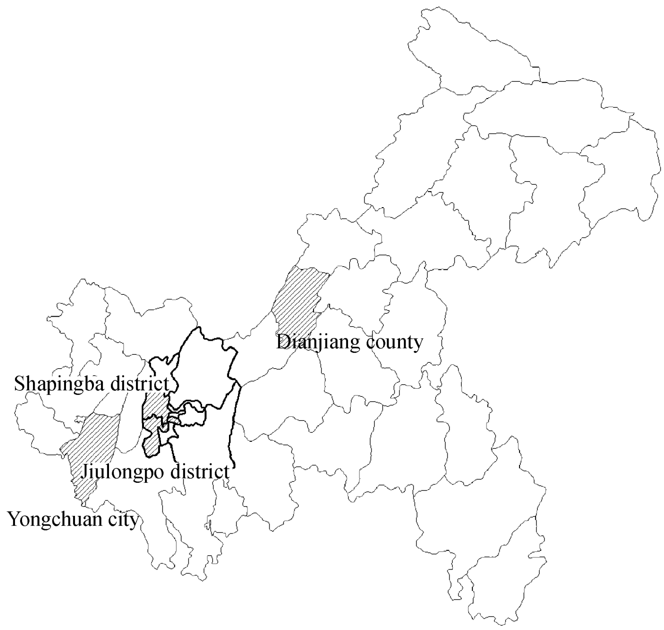

Fig. 1 Map of Chongqing, China
(The areas with solid borders are the city zone, and the shaded counties and districts are the study areas)

were required to record the time they spent over seven consecutive days in seven microenvironments (MEs) including kitchen, bedroom, living room, classroom/office, other indoors away from home (i.e., public indoor places, e.g., shopping mall), transit, and outdoors. Therefore, the records indicated which ME they were in for each hour of the day. Information such as the participants' gender, age, occupation, education status, and annual household income were also recorded.

The records of time spent on one day in various MEs which were not equal to 24 h were considered misreporting and were excluded from the analysis. In total, 1608 participants from 569 families were certified, as listed in Table 1.

Table 1 Number of feedback questionnaires for each sampling period and location (classified with demographic factors)

			period 1[a)]					period 2[b)]				total
			JLP	SPB	YC	subtotal	DJ	JLP	SPB	YC	subtotal	
family	residence	rural	84	0	0	84	38	78	0	38	154	238
		urban	0	91	92	183	41	0	68	39	148	331
	total		84	91	92	267	79	78	68	77	302	569
participants	residence	rural	249	0	0	249	122	172	0	111	405	654
		urban	0	261	262	523	146	0	176	109	431	954
	gender	male	127	124	135	386	130	83	88	110	411	797
		female	122	137	127	386	138	89	88	110	425	811
	age	0–15	84	93	93	270	50	73	22	77	222	492
		16–64	151	160	165	476	207	88	147	134	576	1052
		> 64	4	7	4	15	7	10	7	9	33	48
		misreport	10	1	0	11	4	1	0	0	5	16
	education[c)]	level 1	130	4	18	152	68	64	7	132	271	423
		level 2	115	154	223	492	198	106	140	86	530	1022
		level 3	0	101	19	120	1	1	27	2	31	151
		misreport	4	2	2	8	1	1	2	0	4	12
	total		249	261	262	772	268	172	176	220	836	1608

Notes: a) January–March of 2006; b) October–December of 2006; c) level 1: illiterate or primary school, level 2: middle and high school, level 3: college or above

2.2 Data analysis

Univariate analysis of time-activity patterns was performed using nonparametric methods (Kruskal-Wallis procedure) to account for the non-normality in the data. For each ME, temporal variability was analyzed using time spent in the ME as dependent variable, and sampling period or day of week as independent variable.

Multivariate analysis was conducted using general linear models (GLM) to assess the relationship between time-activity patterns and selected demographic factors such as gender, age, residence (rural or urban), education level, and household income, adjusting to sampling period, location, and day of week. An example of a GLM model for time spent outdoors is shown in Eq. (1) [7]. In this study, three levels of age were used in the analysis: youth under 16, adults between 16 and 64, and senior citizens over 64. For education level and household income, the student cases were excluded because the students had not reached their highest education level and had no earned income. Levels of education were divided into three categories: primary school and below, middle and high school graduate, and college and above. Levels of annual household income (RMB) were grouped as less than 5000 yuan, 5000–20000 yuan, 20000–50000 yuan, and more than 50000 yuan, respectively.

$$\text{Outdoors} = \beta_0 + \beta_1\text{CYCLE} + \beta_2\text{LOCATION} + \beta_3\text{DAY} + \beta_4\text{AGE} \quad (1)$$

Both the nonparametric analysis and the GLM analysis were performed with Statistical Package for the Social Sciences (SPSS) 13.0.

3 Results

3.1 General statistic descriptive

In total, data for 11110 person-days of time-activity patterns were valid in this analysis (5342 in period 1 and 5768 in period 2). Descriptive statistics of microenvironmental time budgets for each period and location are listed in Table 2. The mean time spent "outdoors" ranged from 2.1 h (in SPB during period 1) to 4.8 h (in SPB during period 2). The mean time spent in "transit" ranged from 0.9 h (in JLP during period 2) to 1.5 h (in YC during period 2). The mean time spent in "living room" ranged from 1.8 h (in DJ during period 2) to 3.2 h (in SPB during period 1). The mean time spent in "bedroom" ranged from 8.3 h (in DJ during period 2) to 10.8 h (in JLP during period 1). The mean time spent in "kitchen" ranged from 0.6 h (in SPB during period 2) to 2.0 h (in JLP during period 1). The mean time spent in "classroom/office" ranged from 2.1 h (in JLP during period 1) to 6.0 h (in SPB during period 1). The mean time spent in "other indoors" ranged from 0.8 h (in SPB during period 2) to 3.2 h (in DJ during period 2). On a one-day average, people in Chongqing spent the most time in "bedroom", and the least in "transit". Regarding the sampling location, the people in JLP spent most time at home and least in "outdoors" and "classroom/office" than other districts/counties, while the people in DJ spent most time in "outdoors" and least at home, and the people in SPB spent most time in "classroom/office". The p-value for the Kruskal-Wallis test by period was 0.850 for "transit" and less than 0.005 for other MEs, implying that the effect of sampling period was significant for all MEs except for "transit". People spent more time at home but less in "outdoors" and "other indoors" in winter (period1) than in autumn (period 2). The percentiles of time spent in each ME are shown in Fig. 2, which confirmed the asymmetric distribution of the data, particularly for "outdoors", "transit", "classroom/office", and "other indoors". Half or even more of the population did not spend any time in "transit", "classroom/office", and "other indoors" during the sampling period. Therefore, the doers' (the cases who did spend time in corresponding MEs) mean hours described the time-activity patterns of the related population more accurately than that of the total population. There were large differences between the mean time of the total population and the doers' in "classroom/office" (4.8 h) and "outdoors" (2.3 h), while little difference was noted for "bedroom" (0.4 h) and "living room" (0.8 h).

Results of the one-day hourly analysis are shown in Fig. 3. A double-peak distribution was found for "outdoors", "classroom/office" (8:00–12:00; 13:00–17:00), and "living room" (11:00–13:00; 18:00–22:00). Rural people spent more working time in "outdoors" (mainly on the farm, with the highest 40% at 15:00–16:00), while urban people spent more time in "classroom/office" (with the highest 46% at 10:00–11:00). In addition, rural people spent more time in "kitchen" and "other indoors" but less in "transit".

The average time budget by day of week is shown in Fig. 4. The mean time spent in "outdoors" ranged from 3.4 h (Friday) to 3.5 h (the rest), in "transit" ranged from 0.9 h (Sunday and Saturday) to 1.2 h (Monday and Wednesday), in "living room" ranged from 2.2 h (Monday-Thursday) to 3.4 h (Sunday), in "bedroom" ranged from 9.2 h (Monday) to 10.7 h (Sunday), in "kitchen" ranged from 1.3 h (Monday–Friday) to 1.5 h (Sunday and Saturday), in "classroom/office" ranged from 1.9 h (Sunday) to 5.1 h (Tuesday–Thursday), and in "other indoors" ranged from 1.5 h (Thursday) to 2.1 h (Sunday). From these results, it can be seen that the time-activity patterns were of considerable difference between weekdays and weekends. Generally, people spent more time in "classroom/office" and "transit" but less at home and "other indoors" during weekdays (Monday–Friday). The p-value

Table 2 Descriptive statistics for microenvironmental time budgets in hours per day by period and location

time	location	statistics	outdoor	transit	living room	bedroom	kitchen	classroom /office	other indoors
			$p < 0.005$	$p = 0.850$	$p < 0.005$	$p < 0.005$	$p < 0.005$	$p < 0.005$	$p < 0.005$
period 1	JLP	mean	3.8	1.0	2.4	10.8	2.0	2.1	1.9
		N	1722	1722	1722	1722	1722	1722	1722
		Std. deviation	3.7	2.1	2.1	2.6	2.0	3.7	2.7
		median	3.0	0.0	2.0	11.0	2.0	0.0	1.0
		doers' mean	5.8	2.4	3.1	10.8	2.7	8.0	3.4
		doers' N	1128	696	1352	1716	1251	454	969
		percentage of doers/%	65.5	40.4	78.5	99.7	72.6	26.4	56.3
	SPB	mean	2.1	1.0	3.2	9.9	0.9	6.0	0.9
		N	1815	1815	1815	1815	1815	1815	1815
		Std. deviation	3.6	1.2	2.8	2.6	1.4	4.9	1.8
		median	1.0	0.0	3.0	10.0	0.0	8.0	0.0
		doers' mean	4.2	2.0	3.9	10.0	2.1	8.8	2.6
		doers' N	913	895	1484	1798	804	1239	595
		percentage of doers/%	50.3	49.3	81.8	99.1	44.3	68.3	32.8
	YC	mean	3.4	1.2	2.7	9.7	1.0	4.4	1.6
		N	1805	1805	1805	1805	1805	1805	1805
		Std. deviation	4.3	1.7	2.5	2.6	1.3	5.1	2.9
		median	1.0	1.0	2.0	9.0	0.0	0.0	0.0
		doers' mean	5.3	2.3	3.3	9.8	2.1	8.9	3.6
		doers' N	1155	965	1466	1799	896	893	791
		percentage of doers/%	64.0	53.5	81.2	99.7	49.6	49.5	43.8
	total	mean	3.1	1.1	2.8	10.1	1.3	4.2	1.4
		N	5342	5342	5342	5342	5342	5342	5342
		Std. deviation	3.9	1.7	2.5	2.6	1.7	4.9	2.5
		median	1.0	0.0	2.0	10.0	1.0	0.0	0.0
		doers' mean	5.1	2.2	3.4	10.2	2.4	8.7	3.2
		doers' N	3196	2556	4302	5313	2951	2586	2355
		percentage of doers/%	59.8	47.8	80.5	99.5	55.2	48.4	44.1
period 2	DJ	mean	3.8	1.0	1.8	8.3	1.9	4.0	3.2
		N	1838	1838	1838	1838	1838	1838	1838
		Std. deviation	3.9	1.3	1.9	3.7	1.6	5.7	3.9
		median	3.0	0.0	2.0	9.0	2.0	0.0	2.0
		doers' mean	5.6	1.9	2.7	9.6	2.5	9.2	4.3
		doers' N	1261	914	1216	1601	1395	807	1350
		percentage of doers/%	68.6	49.7	66.2	87.1	75.9	43.9	73.4
	JLP	mean	2.8	0.9	2.0	9.9	1.5	4.3	2.5
		N	1195	1195	1195	1195	1195	1195	1195
		Std. deviation	4.0	1.9	2.5	3.4	1.7	6.3	3.9
		median	0.0	0.0	1.0	10.0	1.0	0.0	1.0
		doers' mean	6.3	2.4	3.2	10.5	2.4	11.4	4.8
		doers' N	526	472	771	1134	720	451	631
		percentage of doers/%	44.0	39.5	64.5	94.9	60.3	37.7	52.8

(*Continued*)

time	location	statistics	outdoor	transit	living room	bedroom	kitchen	classroom /office	other indoors
			$p < 0.005$	$p = 0.850$	$p < 0.005$	$p < 0.005$	$p < 0.005$	$p < 0.005$	$p < 0.005$
	SPB	mean	4.8	1.0	2.3	9.2	0.6	5.3	0.8
		N	1219	1219	1219	1219	1219	1219	1219
		Std. deviation	6.6	1.9	2.8	4.1	1.1	5.6	1.7
		median	2.0	0.0	1.0	9.0	0.0	5.0	0.0
		doers' mean	8.3	2.3	3.7	10.0	1.9	9.8	2.3
		doers' N	708	519	748	1118	407	666	409
		percentage of doers/%	58.1	42.6	61.4	91.7	33.4	54.6	33.6
	YC	mean	3.9	1.5	3.1	9.9	1.5	3.2	1.1
		N	1516	1516	1516	1516	1516	1516	1516
		Std. deviation	4.2	2.4	2.1	2.7	1.9	4.1	2.1
		median	2.0	1.0	3.0	10.0	1.0	0.0	0.0
		doers' mean	6.4	2.6	3.4	9.9	2.5	7.7	2.7
		doers' N	915	834	1377	1508	906	625	613
		percentage of doers/%	60.4	55.0	90.8	99.5	59.8	41.2	40.4
	total	mean	3.8	1.1	2.3	9.2	1.4	4.1	2.0
		N	5768	5768	5768	5768	5768	5768	5768
		Std. deviation	4.7	1.9	2.3	3.6	1.7	5.5	3.3
		median	2.0	0.0	2.0	10.0	1.0	0.0	1.0
		doers' mean	6.5	2.3	3.2	9.9	2.4	9.4	3.8
		doers' N	3410	2739	4112	5361	3428	2549	3003
		percentage of doers/%	59.1	47.5	71.3	92.9	59.4	44.2	52.1
total		mean	3.5	1.1	2.5	9.7	1.4	4.2	1.7
		N	11110	11110	11110	11110	11110	11110	11110
		Std. deviation	4.4	1.8	2.4	3.2	1.7	5.2	3.0
		median	1.0	0.0	2.0	10.0	1.0	0.0	0.0
		doers' mean	5.8	2.3	3.3	10.1	2.4	9.0	3.6
		doers' N	6606	5295	8414	10674	6379	5135	5358
		percentage of doers/%	59.5	47.7	75.7	96.1	57.4	46.2	48.2

Notes: p-value was obtained from Kruskal-Wallis test by period; N is the number of person-days; doers represent the cases who did spend time in corresponding MEs.

Fig. 2 95%, 75%, 50%, 25%, and 5% percentiles of the hours spent in MEs based on a one-day average

of Kruskal-Wallis test by the day of week was 0.867 for outdoors and less than 0.005 for the others, implying that the day of week was significant for all MEs except for "outdoors".

3.2 Demographic covariates

Gender Males spent more time in "outdoors" and "transit", while females spent more in "kitchen" and "other indoors", as shown in Table 3. There is little difference between male and female for the time spent in "living room", "bedroom", and "office" (p-values of GLM were 0.672, 0.173, and 0.121, respectively).

Age The time spent in each ME was found to vary

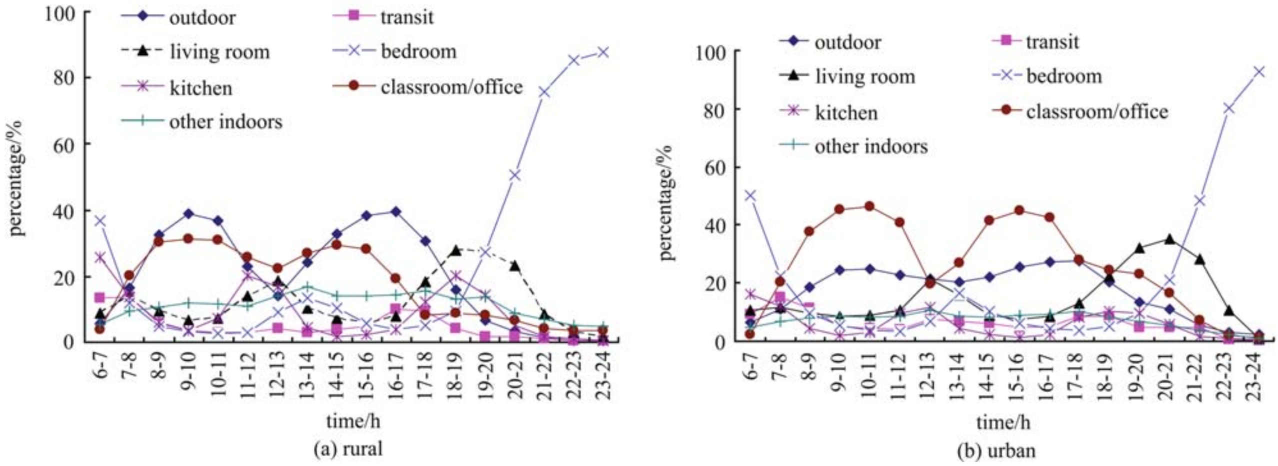

Fig. 3 Percentages of people in various microenvironments for each hour from 6:00 to 24:00

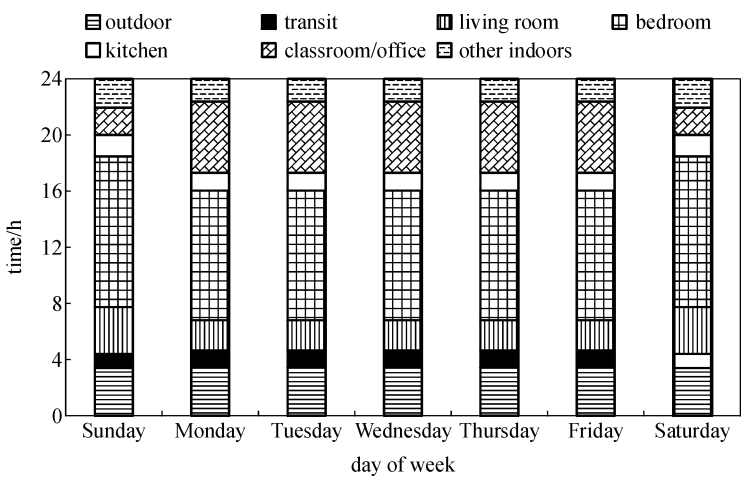

Fig. 4 Average time spent by the day of a week

significantly ($p < 0.005$) by age group, as shown in Table 4. The youth spent more time in "classroom" but less in "outdoors" than adults and senior citizens did, since most teenagers received compulsory education. Adults spent more working time in "outdoors". The youth and adults spent similar time in "transits". However, the senior citizens spent most time at home ("living room", "bedroom", and "kitchen").

Residence Rural people spent more time in "outdoors" and "kitchen", but less in "transit" and "classroom/office" than urban people did (see Table 5). Many farmers had to work on the farm during the planting and harvest periods. For "living room" and "other indoors", there was no significant difference when residence was concerned (p = 0.806 and 0.103, respectively).

Education The time budget in each ME by education level is shown in Table 6. People with higher education spent less time in "outdoors", "kitchen", and "other indoors". The time spent in "office" by people with the highest education level (college or above) was 7.8 times greater than that by people with the lowest level (primary school or illiterate).

Household income The time-activity patterns by household income were similar to that by education (see Table 7). People with higher income spent less time in "outdoors", "kitchen", and "other indoors" but more time in "office" and "living room". However, there was no significant difference in the time spent in "transit" when household income was concerned (p = 0.261).

4 Discussion and conclusions

This study was designed to estimate Chinese time-activity patterns in seven MEs during two different seasons and among people within selected demographic groups.

Table 3 Descriptive statistics and multivariate GLM results for microenvironmental times by gender

ME	gender	N[a)]	mean	Std. deviation	median	p[b)]
outdoor	M	5509	3.7	4.6	2.0	< 0.005
	F	5601	3.2	4.1	1.0	
transit	M	5509	1.3	2.2	1.0	< 0.005
	F	5601	0.9	1.3	0.0	
living room	M	5509	2.5	2.4	2.0	0.672
	F	5601	2.5	2.4	2.0	
bedroom	M	5509	9.6	3.2	10.0	0.173
	F	5601	9.7	3.2	10.0	
kitchen	M	5509	1.1	1.4	1.0	< 0.005
	F	5601	1.7	1.9	1.0	
classroom /office	M	5509	4.2	5.2	0.0	0.121
	F	5601	4.1	5.2	0.0	
other indoors	M	5509	1.5	2.7	0.0	0.000
	F	5601	1.9	3.2	1.0	

Notes: a) N is the number of person-days; b) p-value of multivariate GLM controlling for period, location, and day of the week.

Table 4 Descriptive statistics and multivariate GLM results for microenvironmental times by age

ME	age	N[a)]	mean	Std. deviation	median	p[b)]
outdoor	0–15	3411	1.6	2.9	0.0	< 0.005
	16–64	7253	4.3	4.7	3.0	
	> 64	336	3.9	3.5	3.0	
transit	0–15	3411	1.1	1.2	1.0	< 0.005
	16–64	7253	1.1	2.0	0.0	
	> 64	336	0.3	0.7	0.0	
living room	0–15	3411	2.2	2.3	2.0	< 0.005
	16–64	7253	2.6	2.4	2.0	
	> 64	336	4.0	3.0	3.0	
bedroom	0–15	3411	9.9	2.8	10.0	< 0.005
	16–64	7253	9.5	3.4	10.0	
	> 64	336	11.1	2.6	11.0	
kitchen	0–15	3411	0.7	1.1	0.0	< 0.005
	16–64	7253	1.6	1.8	1.0	
	> 64	336	2.5	2.2	3.0	
classroom/office	0–15	3411	7.4	4.7	8.0	< 0.005
	16–64	7253	2.9	4.8	0.0	
	> 64	336	0.1	0.7	0.0	
other indoors	0–15	3411	1.0	2.0	0.0	< 0.005
	16–64	7253	2.0	3.2	1.0	
	> 64	336	2.1	3.1	0.0	

Notes: a) N is the number of person-days; b) p-value of multivariate GLM controlling for period, location, and day of the week.

Different from most studies carried out in developed countries, "indoor home" in this study was divided into three MEs: "living room", "bedroom", and "kitchen". The main reason is that in China the level of indoor air pollution in kitchens (particularly for rural areas) is much higher than that in other rooms because of burning of solid fuels for cooking and poor ventilation, which should be considered in the exposure assessment [5]. The results indicated that the time budget varied significantly by sampling period (i.e., season) in all MEs except for

Table 5 Descriptive statistics and multivariate GLM results for microenvironmental times by residence

ME	residence	N[a)]	mean	Std. deviation	median	p[b)]
outdoor	urban	6583	3.3	4.6	1.0	< 0.005
	rural	4520	3.8	4.0	2.0	
transit	urban	6583	1.2	1.7	1.0	< 0.005
	rural	4520	1.0	2.0	0.0	
living room	urban	6583	2.7	2.5	2.0	0.806
	rural	4520	2.3	2.3	2.0	
bedroom	urban	6583	9.7	2.8	10.0	< 0.005
	rural	4520	9.6	3.7	10.0	
kitchen	urban	6583	1.1	1.4	1.0	< 0.005
	rural	4520	1.8	2.0	1.0	
classroom /office	urban	6583	4.8	4.9	4.0	< 0.005
	rural	4520	3.3	5.4	0.0	
other indoors	urban	6583	1.3	2.4	0.0	0.103
	rural	4520	2.3	3.6	1.0	

Notes: a) N is the number of person-days; b) p-value of multivariate GLM controlling for period, location, and day of the week.

Table 6 Descriptive statistics and multivariate GLM results for microenvironmental times by education level (students were excluded from the analysis)

ME	education level	N[a)]	mean	Std. deviation	median	p[b)]
outdoor	level 1	1435	5.5	4.1	6.0	< 0.005
	level 2	4488	4.4	4.6	3.0	
	level 3	1044	2.5	4.0	0.0	
transit	level 1	1435	0.8	1.9	0.0	< 0.005
	level 2	4488	1.2	2.2	0.0	
	level 3	1044	1.2	1.5	1.0	
living room	level 1	1435	2.6	2.1	3.0	0.018
	level 2	4488	2.7	2.4	2.0	
	level 3	1044	3.3	2.9	3.0	
bedroom	level 1	1435	9.9	3.1	10.0	< 0.005
	level 2	4488	9.8	3.0	10.0	
	level 3	1044	9.7	2.5	10.0	
kitchen	level 1	1435	2.5	2.1	2.0	< 0.005
	level 2	4488	1.7	1.8	2.0	
	level 3	1044	1.0	1.2	1.0	
classroom/office	level 1	1435	0.6	2.3	0.0	< 0.005
	level 2	4488	1.9	3.8	0.0	
	level 3	1044	5.3	4.5	7.0	
other indoors	level 1	1435	2.1	2.9	1.0	< 0.005
	level 2	4488	2.1	3.4	1.0	
	level 3	1044	1.0	2.0	0.0	

Notes: a) N is the number of person-days; b) p-value of multivariate GLM controlling for period, location, and day of the week.

"transit". Therefore, seasonal differences in time-activity patterns should be taken into account when the time budget data are used in assessing population exposure. Similarly, the time spent in all MEs except for "outdoors" varied significantly by day of the week, implying that the weekday exposure and the weekend exposure can be substantially different. The influence of demographic factors is complicated, and the time-activity patterns of different demographic groups highly depend on their lifestyles. For example, in most rural areas of Chongqing, women do more kitchen work at home while men usually work outside either on the farm or building site, and people

Table 7 Descriptive statistics and multivariate GLM results for microenvironmental times by annual household income (students were excluded from the analysis)

ME	incoming (RMB)/ yuan	N[a)]	mean	Std. deviation	median	$p^{b)}$
outdoor	< 5000	2869	4.8	4.3	5.0	< 0.005
	5000–20000	1986	4.5	5.2	3.0	
	20000–50000	874	3.0	3.9	1.0	
	> 50000	260	2.4	3.6	1.0	
transit	< 5000	2869	1.1	2.2	0.0	0.261
	5000–20000	1986	1.3	2.2	0.0	
	20000–50000	874	1.2	2.0	0.0	
	> 50000	260	1.2	2.2	1.0	
living room	< 5000	2869	2.5	2.2	2.0	0.009
	5000–20000	1986	2.8	2.5	2.0	
	20000–50000	874	3.2	2.7	3.0	
	> 50000	260	3.2	2.9	3.0	
bedroom	< 5000	2869	9.8	2.9	10.0	< 0.005
	5000–20000	1986	9.6	3.2	10.0	
	20000–50000	874	10.0	2.4	10.0	
	> 50000	260	10.1	2.1	10.0	
kitchen	< 5000	2869	2.0	1.9	2.0	< 0.005
	5000–20000	1986	1.4	1.5	1.0	
	20000–50000	874	1.4	1.6	1.0	
	> 50000	260	1.1	1.9	0.0	
classroom/office	< 5000	2869	1.5	3.5	0.0	< 0.005
	5000–20000	1986	2.7	4.2	0.0	
	20000–50000	874	3.4	4.2	0.0	
	> 50000	260	4.5	4.2	5.0	
other indoors	< 5000	2869	2.2	3.2	1.0	< 0.005
	5000–20000	1986	1.8	3.0	0.0	
	20000–50000	874	1.7	3.4	0.0	
	> 50000	260	1.4	2.7	0.0	

Notes: a) N is the number of person-days; b) p-value of multivariate GLM controlling for period, location, and day of the week.

in relatively developed urban areas spend most their working time in the office. According to our analysis, age was the most significant factor, followed by education level, household income, and residence, while the difference by gender was only important for certain MEs, e.g., "outdoors" and "kitchen". Since information on education level and household income are usually unavailable, whereas to some extent related to residence (urban or rural), it is recommended that the population be classified by age and residence when evaluating human exposure in a city or on a larger scale.

The accuracy of the data collected was a limitation of this study. For each hour of the day, participants recorded only the ME where they spent most of the time, neglecting other possible MEs they had visited, which made our analysis results a little coarser compared with the real situation. In addition, questionnaires were sent to households, which usually consisted of husband, wife, and one child (the typical "one-child" family) because of the planned parenthood policy starting from the end of the 1970s. In this way, only 3% of the total valid cases were obtained from the senior citizens, while the senior citizens account for 8% of the total population in Chongqing. This implies some uncertainty in evaluating the time-activity patterns for the senior citizens.

In North America and Europe, people spent 4%–11% of time in "outdoors", 4%–8% in "transit", 57%–68% in "indoors at home", and 17%–31% in "indoors away from home" [2,3,7,8]. Compared with that, people in Chongqing spent more time in "outdoors" but less time in "transit" and "home" (14%, 5%, and 56%, respectively). Another study [10] investigated the time budget in rural Anqing, Anhui Province, China, which is at nearly the same latitude as Dianjiang, Chongqing, and found that people spent 14%, 4%, 53%, and 29% of time in "outdoors", "transit", "home", and "indoors away from home", respectively, which is very close to what we found in rural areas of Chongqing (16%, 4%, 57%, and 23%, respectively). The study in Hong Kong [12] and Beijing [9] found lower percentage in "outdoors" than that in urban areas of Chongqing (4% and 11% vs. 14%), but higher percentage in "indoors away from home" (31% and 42% vs. 25%). These comparisons imply that time-activity patterns might be influenced by the geographical location, climate, and social-economic development. To better assess the human exposure patterns in China, more studies on time-activity patterns are thus suggested for the rest of the country.

Acknowledgements This work was supported by the Environmental Decision Making in China (DEMAND) funded by the Norwegian Agency for Development Cooperation (No. CHN-2087). Besides that, we wish to acknowledge the help provided by Jia Xing, Hongying Dou, and Qixun Zhou of Tsinghua University. We also thank Professor Jerry M Davis for his great help in editing this paper.

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