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Who exhibits more energy-saving behavior in direct and indirect ways in china? The role of psychological factors and socio-demographics

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HIGHLIGHTS

- A survey is used to explore Chinese urban residents' energy curtailment behaviors.
- Make a distinction between direct and indirect energy curtailment behaviors.
- Effects of demographic and psychological variables are different on two behaviors.
- Policy should target at specific behaviors and specific population.

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ABSTRACT

This research explores the possibilities for further energy saving in households in the Chinese context by conducting of a survey on energy curtailment behaviors. We examine how people's demographic characteristics and psychological factors affect their direct and indirect energy curtailment behaviors at home, as well as the different effects of these antecedents. Results suggest that people with high sense of environmental responsibility and curtailment attitude are more likely to engage in both direct and indirect energy curtailment actions. Generally, indirect energy curtailment behavior is more strongly related to psychological and socio-demographic factors than direct behavior, and these socio-demographic factors vary for direct and indirect behaviors. Interesting patterns emerged with respect to gender, age, family structure, family income, and level of education. Results indicate that strengthening publicity and education to increase environmental awareness among Chinese urban residents would be effective in reducing household energy consumption, especially when the said measures target a specific population and specific behaviors.

1. Introduction

Residential energy consumption typically accounts for approximately 10% of China's total energy use and related carbon emissions (Source: China Statistical Year Book). Along with the decrease of energy consumption per GDP of China's industrial sector (Wang and Yang, 2015), residential energy consumption is expected to continuously increase. This increase, which has been observed since 2001, indicates that households constitute an important target group for energy conservation and should be the focus of future attempts aimed at decreasing energy consumption and carbon emissions. As the researches that have been taken in industrial sectors have greatly contributed to the design of policies to reduce the industrial energy consumption and carbon emissions in China (Zhang, 2003; Wang et al., 2012, 2015), the energy consumption in long overlooked residential sector also calls for attention from the scholar's point of view. In the west, household energy conservation has been an important research topic for decades because of energy shortage and the negative consequences of fossil energy use to the environment (Poortinga et al., 2003). Numerous studies have given insights into household energy use/conservation (Steg, 2008; Benders et al., 2006; Brandon and Lewis, 1999) and its relevant factors (Martinsson et al., 2011; Poortinga et al., 2003). Researchers also evaluated the effectiveness of interventions aiming to encourage households to reduce energy consumption (Abrahamse et al., 2005), indicating the importance of studying household energy saving potentials and approaches which could be used to better guide the design of policies.

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Different measures can be implemented to reduce household energy use. Although technical improvement and behavioral endeavor constitute two main aspects (Stern and Gardner, 1981; Poortinga et al., 2003), these aspects have different properties (Gardner and Stern, 1996). Bentzen (2004) and Wang et al. (2014) found that the rebound effect has weakened the development of energy-efficiency technology and has even led to higher energy usage in China's residential sector. This effect, in turn, highlights the importance of behavioral change in household energy use, which is presently gaining popularity.

For households, such energy-saving behaviors that are performed repeatedly and are associated with a change in everyday life as curtailment have been assumed to have important influence on total domestic energy consumption (Aarts and Dijksterhuis, 2000; Marechal, 2009). The prerequisite for the reduction of energy use among residents and the development of effective, targeted communication strategies and marketing instruments is the understanding of their energy curtailment behavior and the careful identification of the factors that influence their behavior.

Most previous studies focused more on direct energy saving at home as exemplified by turning off of the lights in time and rarely on people's indirect energy consumption that reflect their consumption choices. A number of studies proposed that home energy saving is performed both directly and indirectly (Abrahamse and Steg, 2009; Poortinga et al., 2003). Indirect energy use in the residential sector, which refers to energy consumption that is embedded in the goods and services consumed by residents, should also be considered. As indicated by Wang and Feng (2015), guiding consumption behavior toward a sustainable direction plays an effective role in controlling excessive industrial production because consumption behavior affects production as well as transportation behaviors. Moreover, the extent to which households save energy may depend on factors that act as barriers or opportunities for energy conservation, such as income, that may influence purchase decisions and the ability to pay energy bills. Similarly, the decision to reduce energy use is a conscious decision and entails conscious efforts to realize energy savings, indicating that relevant psychological factors would influence energy-saving behaviors.

Therefore, we investigate the behavioral levels of direct and indirect energy curtailment of Chinese urban residents and examine the effects of antecedents on their energy curtailment. Specifically, we aim to obtain the socio-demographic characteristics of Chinese urban residents who save more energy in their daily lives to highlight the most promising groups. Moreover, we aim to elaborate on tailored energy conservation strategies and policies that may encourage others who do not exhibit energy-saving behavior. Our study is distinct and important because it covers both direct and indirect aspects of curtailment behaviors and uses these aspects to fully understand such behaviors. Additionally, our study provides specific policy implications that target at different groups. In this manner, our research can help reduce energy consumption and the corresponding carbon emissions in the residential sector and address the huge energy pressure in China.

In the succeeding section, the concept of energy curtailment behavior and its direct and indirect aspects are introduced. A review of pertinent literature on psychological and socio-demographic variables related to curtailment behaviors is presented. Subsequently, the data and method used in this study are described. The main results of this study are presented, and the findings and their relevance to policies are discussed. Suggestions for future research are also put forward.

2. Literature review

2.1. Direct and indirect energy curtailment

Household energy curtailment behavior can be performed directly and indirectly. Direct energy use refers to daily domestic energy consumption using gas, electricity, and water, among others. Indirect energy use refers to energy consumption that is embedded in the goods and services consumed by residents. The availability of consumer goods and services has energy implications because of the use of fossil fuels in the production, transportation, and distribution processes. The choice and purchase of goods and services involves indirect energy consumption. Thus, indirect energy use should be considered part of domestic energy consumption. Local food production, for example, uses lesser amount of energy than those of other places, and simplified packaging products are more energy saving than complex packaging ones (Urban and Ščasný, 2012) based on the use of fossil fuels in the transportation and production processes. Accordingly, the direct energy curtailment behavior refers to the reduced use of gas, electricity, and water at home that are achieved through such measures as reducing the temperature setting for heat in unused rooms. Indirect energy use can be reduced by consuming less energy-intensive products, by shifting expenditures to goods with a lower energy intensity, or by shifting expenditures from

energy-intensive goods to energy-extensive services (Poortinga et al., 2003). Thus, indirect energy curtailment behavior refers to the behavior of buying goods and services, such as seasonal foods, that consume less energy and have less carbon implications during production and transportation (Sütterlina et al., 2011; Vringer and Blok, 1995).

Both direct and indirect energy saving occur nearly every day in our life. Approximately half of average household energy use is estimated to be indirect energy use (Reinders et al., 2003). However, compared with domestic direct energy curtailment behavior, indirect energy curtailment behavior has not been investigated in China. This gap should be addressed because further encouragement of both direct and indirect energy curtailment behaviors can potentially relieve the pressure of energy shortage and mitigate carbon emission increase.

2.2. Psychological and socio-demographic antecedents

Key antecedents for energy curtailment behaviors should be identified. Studies showed that different types of environmentally relevant behavior are related to different behavioral antecedents (e.g., Axelrod and Lehman, 1993; McKenzie-Mohr et al., 1995; Stern and Oskamp, 1987). Energy curtailment behavior is influenced by both psychological (Becker et al., 1981; Kaiser et al., 1999, Kaiser and Shimoda, 1999) and demographic factors (Gatersleben et al., 2002; Moll et al., 2005). Understanding the influences of psychological factors and socio-demographics on direct and indirect energy curtailment behaviors would inform policy models and allow the formulation of energy-saving programs for different socio-demographic groups (Ehrhardt-Martinez, 2008). Especially for indirect energy curtailment behavior, Abrahamse and Steg (2009) emphasized that if the aim is to encourage households to consume products with low energy use per unit, indirect energy use and factors related to it must be examined. However, no recent China studies have explored and compared the effects of psychological factors and socio-demographic characteristics on both direct and indirect energy curtailment behaviors. Thus, the current study aims to expand the existing body of knowledge in this area.

Attitude is identified as an important predictor of behavior because it represents the positive or negative evaluation of an individual regarding his or her particular behavior. With regard to

psychological factors, attitude has been defined by a number of studies as an important predictor of behavior (Hines et al., 1986; Kaiser et al., 1999, Kaiser and Shimoda 1999; Nordlund and Garvill, 2002). Furthermore, attitudes toward specific behaviors are much more predictive than general attitudes (Tanner and Kast, 2003). Based on previous research, we identify curtailment attitude as people's positive or negative perspective and judgment toward energy curtailment behaviors and suppose that it is positively related to both direct and indirect energy curtailment behaviors. Thus, we propose the following hypotheses:

H1a: Attitudes positively affects direct energy curtailment behavior.

H1b: Attitudes positively affects indirect energy curtailment behavior.

Other psychological factors influence energy-saving behaviors. We divide these factors into two aspects, namely, environmental responsibility and consumer value, which consider both the pro-environment and consumption characteristics of household energy curtailment. As defined by Hines et al. (1986), environmental responsibility is the individual's sense of responsibility and moral perspective related to the adoption of a specific environment-related behavior intended to address environmental problems. Stern (2000) concluded based on empirical studies and literature review that environmental responsibility is the most fundamental antecedent variable of environmental behaviors. The consumer values of individuals are defined as their overall view and value judgment of consumed objects, consumption behavior, and trends. Energy use is a consumption behavior that involves monetary cost; hence, energy use is assumed to be affected by consumer values. A common dimension of consumer values is its division into materialism and non-materialism (Richins, 1992). Previous research stated that the tendency of materialistic energy consumers is to obtain the benefit of energy cost savings without affecting their quality of life; hence, they are less likely to sacrifice living quality to make energy-saving choice in their daily activities (Sütterlina et al., 2011). However, few empirical studies have verified this statement. Previous research (Brandon and Lewis, 1999) showed that compared with direct energy curtailment behavior which is more habitual, indirect energy curtailment behavior requires a higher amount of conscious effort probably because psychological variables (i.e., attitude, consumer value, and environmental responsibility) are more strongly related to indirect energy curtailment than to direct energy curtailment behavior. Hypothsis 2a/b and 3a/b are proposed as follows:

H2a. : Environmental responsibility positively affects direct energy curtailment behavior.

H2b. : Environmental responsibility positively affects indirect energy curtailment behavior.

H3a. : Non-materialism consumer value positively affects direct energy curtailment behavior.

H3b. : Non-materialism consumer value positively affects indirect energy curtailment behavior.

The most frequently examined socio-demographic factors that affect direct energy curtailment behaviors and home energy consumption include age, gender, household income, and level of education. Most previous studies have demonstrated the following: (1) age has a positive relationship with the consumption of energy (Brandon and Lewis, 1999; Yohanis et al., 2008), (2) females exhibit more energy-saving behaviors in their daily lives than males (Carlsson-Kanyama and Lindén, 2007; Thøgersen and Grønhøj, 2010), (3) households with higher income tend to use more energy than those with lower income (Abrahamse and Steg 2009), and (4) people with high education level conduct more pro-environmental behaviors than those with low education level (Scott and Willits, 1994; Widegren, 1998). However, these results remain controversial. The effects of socio-demographics sometimes vary according to cultural contexts (Chan, 1996). In addition to the previously mentioned factors, family structure variables have been observed to exert influence as well. Children, for example, contribute to home energy use; thus, families with children tend to consume more energy and exhibit less energy-saving behavior in their daily lives (Aydinalp et al., 2002, 2004). By contrast, McMakin et al., (2002) found an opposite result. Most Western studies have found that the presence of the elderly in the household can increase energy bills and reduce the conduct of energy-saving behaviors (Sardianou, 2005). This finding is in contrast to that of Chinese studies (Sun, 2006). Furthermore, marital status was also observed to have varied effects on energy-saving behavior (Poortinga et al., 2003). Generally, studies have presented varied findings on the effects of socio-demographic variables. However, minimal research has been conducted to compare these variables. Thus, we examine the effects of socio-demographic variables on both the direct and indirect household energy curtailment behaviors among Chinese urban residents.

3. Methods

3.1. Sampling

We designed a survey questionnaire through which we identify people's attitudes toward daily direct and indirect energy curtailment behaviors. We collected socio-demographic information of the respondents, including gender, age, education, monthly household income, presence of children under 12 years old in the household, and so on, through the questionnaire. A total of 700 questionnaires were distributed to residents of three different-sized cities in China, namely, Hefei in Anhui Province (medium-sized city), Anyang in Henan Province (small-sized city), and Beijing (mega city), from October to December 2012. Three hundred respondents from Hefei were recruited, which comprised MBA students from the University of Science and Technology of China and randomly selected pedestrians from the major streets of each district. We adopted a combined sampling method in Hefei to avoid obtaining a biased sample because most of the MBA students were middle-aged and high-income earners. In Beijing, we randomly sent 200 questionnaires to the parents or grandparents of students from a large training institution. In Anyang, 200 questionnaires were distributed to either the parents or grandparents of students from a public primary school and a private primary school. The limitation of the sampling method may slightly bias the sample. Considering that selecting MBA student as samples may bias the random income distribution and the education level of the respondents in Hefei, we also selected random pedestrian in major streets to balance, whose income levels are under the average levels. However, the overall education level of the sample is still higher than the national statistics. Besides, selecting primary school student's parent will predetermine the householders' age. The ages of the sample are slightly lower than the national statistics of urban residents. In sum, we received 592 responses, yielding a valid response rate of 85%. Of the 592 returned questionnaires, 66 were incomplete or considered “problematic” (e.g., the respondents chose the same values for all items based on a Likert scale, including all the reversed items). After excluding these questionnaires, a total of 526 valid questionnaires were subjected to data analysis. *T*-test, ANOVA, structural equation modeling and OLS regression were performed on the final dataset.

3.2. Measures

The four-page survey consists of eight parts. We developed the questionnaire based on previously validated measures. We analyzed the responses to the items in Part 1 (psychological variables), Part 2 (direct and indirect energy curtailment behavior), and Part 6 (socio-demographic variables). All items except socio-demographic variables were measured using a five-point Likert scale. Energy curtailment behaviors were measured by adopting six items from the research scale of Sütterlina et al., (2011). We measured people's energy curtailment behaviors in the household rather than the real energy consumption or energy saving. This is because that: (1) what we're focusing on are people's subjective initiatives and the factors that influence their energy saving behaviors, so that we could raise helpful implications to promote such behaviors;(2) real energy consumption and energy saving are decided by a number of variables that are difficult to be controlled. Typical daily energy curtailment behaviors, such as "turn off the lights when I leave a room," "turn off the power source of household appliance when it's unused," "set the controls of appliances to save energy (i.e., set the thermostat of the air-conditioner at a higher temperature in summer)," "choose products with simplified packaging," "choose locally produced vegetables and fruits," and "choose fruits and vegetables in season," were evaluated using a five-point Likert scale, ranging from 1 "Never" to 5 "All the time." The first three items are direct curtailment behaviors, whereas the other three are indirect curtailment behaviors. The scales are reliable, with Cronbach's Alpha of 0.792 and 0.702, respectively. Cronbach's α is used as a (lowerbound) estimate of the reliability of a psychometric test.

Respondents were presented with three statements reflecting their energy curtailment attitudes. They were asked to indicate, using a five-point Likert scale, how much they agree with each statement. The scale ranges from 1 "strongly disagree" to 5 "strongly agree." The scale is reliable, with Cronbach's Alpha of 0.835 (see Table A.1 in the Appendix). Items for energy curtailment attitude include "I like the idea of saving energy every day," "I approve of using less energy every day," and "I'm interested reducing my energy usage every day."

Three items on consumer value were scored using a five-point Likert scale (from 1 "strongly disagree" to 5 "strongly agree"). These items were adapted from the revised materialism value scale of Richins (2004). The scale is reliable, with Cronbach's Alpha of 0.714 (see Table A.1 in the Appendix). Items for consumer value include "I like a luxurious life," "The things I own say a lot about how well I'm doing in life," and "It sometimes bothers me quite a bit that I can't afford to buy all the things I like."

Five items on environmental responsibility were assessed using a five-point Likert scale (from 1 "strongly disagree" to 5 "strongly agree"). The items were adapted from SRS (Berkowitz and Danniels, 1964) and the environmental responsibility scale (Gärling et al., 2003). The scale is reliable, with Cronbach's Alpha of 0.753 (see Table A.1 in the Appendix). Sample items for environmental responsibility include "Authorities and enterprises rather than the citizens are responsible for the environment and saving energy," "I have an obligation to save energy," and "Every citizen must take responsibility for the environment."

The last component captures the respondent's demographic characteristics. Questions on demographics include gender, education, marital status, household income, dwelling tenure, presence of children under 12 in the household, presence of person over 60 in the household, and gender of the household reference person (HRP). Regarding household income, we asked the total monthly household income using a response scale with five categories, from under RMB 2000 to over RMB 20,000. Table A.1 in the Appendix shows the details of the reliability of the psychological factors and of the direct and indirect energy curtailment behaviors. Table A.2 in the Appendix shows the means, standard deviations, and correlations for all the variables in this study. Confirmation factor analysis was conducted to examine validity. All factor loadings are presented in Table A.3 in the Appendix.

Table 1
Demographic characteristics of respondents.

Demographics	Category	Frequency	Valid percent (%)
Gender	1. Male	236	45.4
	2. Female	284	54.6
Age	1. Under 20	15	2.9
	2. 20–29	187	35.9
	3. 30–39	254	48.8
	4. 40–49	54	10.4
	5. Over 49	11	2.2
Education level	1. Junior middle school or below	59	11.4
	2. Senior middle school	138	26.6
	3. Associate degree or bachelor degree	250	48.2
	4. Mater's or doctoral degree	72	13.9
Household income	1. Less than RMB 2000	53	10.3
	2. RMB 2001 – 5000	244	47.5
	3. RMB 5001 – 10,000	168	32.7
	4. Over RMB 10,000	49	9.5

$N=526$.

3.3. Sample characteristics

The socio-demographics of the sample in this research were compared with those of the national statistics of urban residents. Table 1 shows that 45.4% of the respondents are males, the percentage of which is slightly lower than but close to the total percentage of males among the number of Chinese urban residents in 2012 (51.27%, China Statistical Yearbook, 2013). Majority of the respondents have a high level of educational attainment, with 62.1% holding a junior college degree or higher. The educational level of the sample is significantly higher than that indicated in the national statistics (21.5%, China's Sixth National Population Census 2010), which may be partly attributed to the exclusion of children and the elderly from the survey.

The sample comprises people with varying income levels. Majority of the respondents (80.2%) are those with family income between RMB 2000 and RMB 10,000. Specifically, 47.5% have income ranging from RMB 2001 to RMB 5000 and 32.7% have income ranging from RMB 5001 to RMB 10,000. The distribution of income generally resembles that in the national statistics, which shows that 41.5% of urban households have a monthly income ranging from RMB 2001 to RMB 5000 and 35.9% of urban households have a monthly income ranging from RMB 5001 to RMB 10,000. The national urban household income is calculated based on the disposable income of urban residents (China Statistical Yearbook, 2013) and the average number of persons per urban household (China's Sixth National Population Census, 2010). By comparing the characteristics of the objective population and the study sample, we found that our sample favorably represents the urban residents in China, but may misrepresent those with high educational level, which may be attributed to the age limitation in our sampling.

4. Results

4.1. General responses to energy curtailment behaviors

Fig. 1 summarizes the responses to three direct and three indirect energy curtailment behaviors. For each of the six curtailment behaviors, at least half of the survey respondents claimed that they are more likely to exhibit energy-saving behaviors in their daily life, but the ratios vary. As shown in Fig.1, the respondents who responded that they turn off lights when they leave a room "all the time" and "most of the time" accounts for 93.3% of all respondents, which is the highest ratio among all types of behaviors. By contrast, purchasing products with simplified packaging seems the least popular daily energy-saving behavior; 52% respondents stated that they did this all the time or most of the time. The proportions of the remaining four behaviors range from 59.2% to 71.1% for the above options ("all the time" and "most of the time"). Generally, respondents engage in direct energy curtailment behaviors more often than indirect curtailment behaviors.

4.2. The role of attitudes

Structural equation modeling method is used to test three psychological variables' (i.e. curtailment attitude, environmental responsibility and consumer value) influences on direct and indirect energy curtailment behaviors separately through AMOS 21.0. The results indicate that the hypothesized model fit the data very well: $\chi^2(110) = 332.687$, $p \le 0.001$; CFI=0.938; TLI=0.923 and RMSEA=0.062.

Fig. 2 presents the results of structural equation modeling. As shown in the path analysis, curtailment attitude ($\beta=0.11$, $p \le 0.05$) and environmental responsibility ($\beta=0.08$, $p \le 0.05$) positively affects direct energy curtailment behavior, supporting Hypotheses 1a and 2a. curtailment attitude ($\beta=0.11$, $p \le 0.1$) and environmental responsibility ($\beta=0.08$, $p \le 0.05$) positively affects indirect energy curtailment behavior, supporting Hypotheses 1b and 2b. Furthermore, we found that consumer value positively affects indirect energy curtailment behavior ($\beta=0.22$, $p \le 0.001$) but was not significantly related to direct energy curtailment behavior ($\beta=-0.01$, n.s.). Hence, Hypothesis 2b was supported but Hypothesis 2a was not supported. Generally, psychological factors show more influence on indirect energy curtailment behavior, which might be ascribed to the fact that indirect curtailment behavior involves more consciousness than direct behavior does.

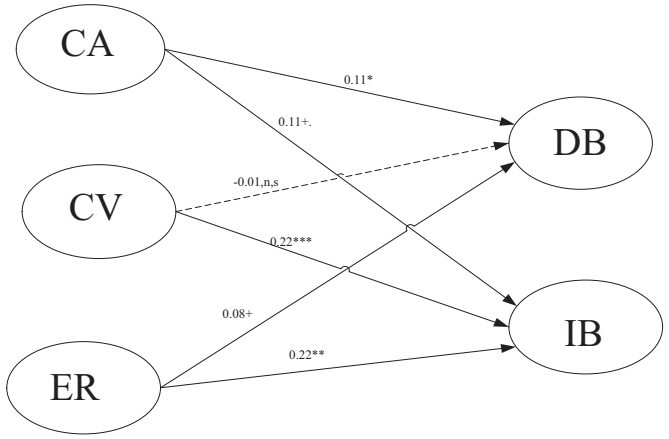

Fig.2. Results of path analysis $N=526$ (missing values were replaced using average value of a column); *** $p \le 0.001$; ** $p \le 0.01$; * $p \le 0.05$; + $p \le 0.1$ (two-tailed). CB represents curtailment behavioral attitude, CV represents consumer value, ER represents environmental responsibility, DB represents direct energy curtailment behavior, IB represents indirect energy curtailment behavior.

4.3. Who are more energy-saving in direct and indirect ways?

T-test of the independent samples and one-way ANOVA were implemented to investigate the differences among demographic groups in terms of direct and indirect energy curtailment behaviors. Gender, age, education, marital status, household income, presence of children under 12 years old in the household, presence of persons over 60 years old in the household, and gender of the HRP were used as grouping variables. Table 2 shows the relationship between socio-demographic variables and direct and indirect energy curtailment behaviors.

4.3.1. Gender

Females conduct more indirect energy curtailment behaviors than males ($t=-4.02$, $p<0.001$). The differences between males and females are not significant for direct energy curtailment.

4.3.2. Marital status

Married people exhibit more direct energy curtailment behaviors than unmarried or single people ($t=2.96$, $p=0.003$). Similarly, married people exhibit more indirect energy curtailment behaviors than single people ($t=7.00$, $p<0.001$). The difference between married and single person for the latter was bigger than that for the former.

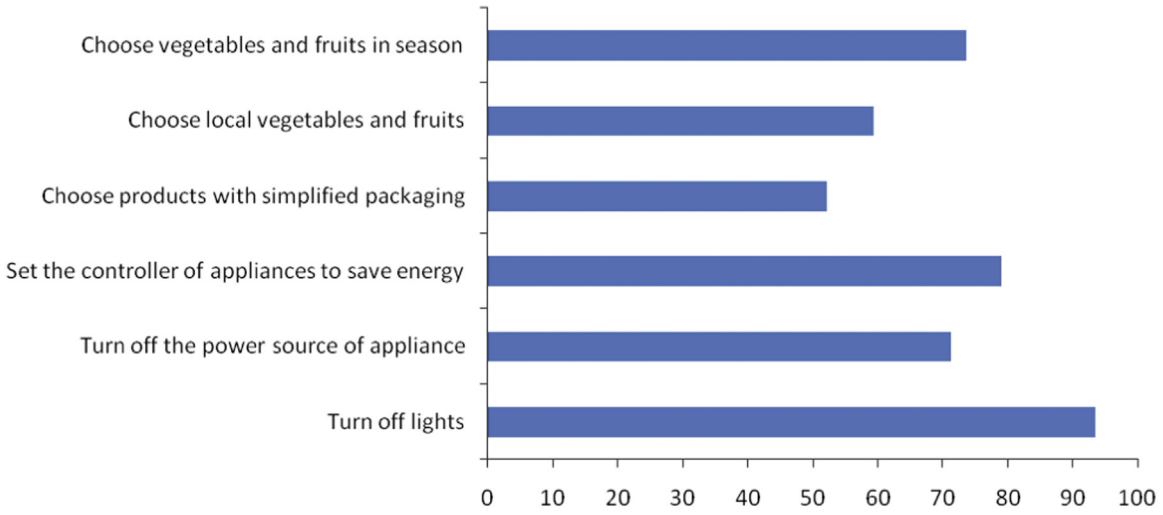

Fig. 1. Residents' energy curtailment behavior frequencies (%) (Responded "all the time" or "most of the time").

Table 2
The results of independent *T* test and one-way ANOVA.

	Direct energy curtailment behaviors				Indirect energy curtailment behaviors			
	Mean	**95% CI for the mean**	**SD**	***n***	**Mean**	**95% CI for the mean**	**SD**	***n***
Gender								
1. Male	4.11	4.00, 4.20	0.79	234	3.49	3.39, 3.58	0.73	236
2. Female	4.17	4.08, 4.26	0.75	278	3.74	3.66, 3.83	0.71	278
t	−0.94=				−4.02≠			
p	0.350				0.000			
Marital status								
1. Married	4.21	4.13, 4.29	0.76	359	3.77	3.70, 3.84	0.68	361
2. Single	3.99	3.87, 4.11	0.772	154	3.29	3.18, 3.41	0.72	154
t	2.96≠				7.00≠			
p	0.003				0.000			
Children under 12 years old in the household								
1. Yes	4.22	4.13, 4.31	0.76	320	3.81	3.74, 3.88	0.67	323
2. No	4.01	3.90, 4.12	0.77	191	3.32	3.21, 3.42	0.73	190
t	3.05≠				7.56≠			
p	0.002				0.000			
People over 60 years old in the household								
1. Yes	4.17	4.06, 4.27	0.75	194	3.71	3.61, 3.81	0.68	198
2. No	4.13	4.04, 4.22	0.78	317	3.58	3.49, 3.66	0.75	315
t	0.56=				2.06≠			
p	0.576				0.040			
Gender of the household reference person								
1.Male	4.11	4.04, 4.19	0.77	423	3.63	3.56, 3.70	0.73	426
2. Female	4.35	4.21, 4.50	0.67	83	3.65	3.49, 3.81	0.73	82
t	−2.88≠				−0.27=			
p	0.005				0.788			
Age								
1. Under 30	3.94	3.84, 4.05	0.81	201	3.30	3.20, 3.40	0.69	201
2. 30−39	4.28	4.19, 4.38	0.71	249	3.83	3.75, 3.91	0.66	250
3. Over 39	4.22	4.03, 4.40	0.73	63	3.85	3.66, 4.02	0.73	64
F	11.69				37.05			
p	0.000				0.000			
Post Hoc Scheffé	*p* (mean dif)	95% CI of mean dif	most statistically significant difference		*p* (mean dif)	95%CI of mean dif	most statistically significant difference	
	0.000	(−0.34) −0.48, −0.20	Group1-Group2		0.000	(−0.55) −0.74, −0.35	Group1-Group2	
Family income								
1. Under 2,000	4.32	4.13, 4.49	0.70	52	3.71	3.53, 3.92	0.73	50
2. 2,001−5,000	4.23	4.14, 4.32	0.73	238	3.78	3.69, 3.86	0.67	242
3. 5,001−10,000	3.99	3.87, 4.11	0.84	167	3.45	3.34, 3.57	0.77	168
4. Over 10,000	4.06	3.85, 4.27	0.77	49	3.41	3.20, 3.62	0.73	48
F	4.38				8.60			
p	0.005				0.000			
Post Hoc Scheffé	*p* (mean dif)	95% CI of mean dif	most statistically significant difference		*p* (mean dif)	95% CI of mean dif	most statistically significant difference	
	0.002	(0.24) 0.09, 0.39	Group2-Group3		0.000	(0.32) 0.18, 0.47	Group2- Group3	
Education								
1. Middle school and lower	4.20	4.01, 4.39	0.73	56	3.78	3.58, 3.98	0.73	57
2. High school	4.23	4.10, 4.35	0.77	137	3.82	3.72, 3.92	0.60	136
3. University and college	4.11	4.01, 4.22	0.79	247	3.62	3.52, 3.72	0.73	248
4. Graduate and higher	4.03	3.85, 4.21	0.72	72	3.14	2.98, 3.30	0.72	72
F	1.33				16.05			
p	0.262				0.000			
Post Hoc Scheffé					*p* (mean dif)	95% CI of mean dif	most statistically significant difference	
					0.000	(0.68) 0.48, 0.88	Group 2-Group4	

F-statistics are for one-way analyses of variance (ANOVAs) for unrelated samples. Where the *F*-statistic is statistically significant to the level of $p < 0.1$, Scheffé post-hoc multiple comparisons were computed and the most statistically significant mean difference is reported.
T-tests were for the equality of two means; the symbol "=" is used where equal variances were assumed between the two groups; the symbol "≠" is used where equal variances were *not* assumed between the two groups.

4.3.3. Presence of children under 12 years old in the household

Households with children under 12 years old conduct more direct ($t=3.05$, $p=0.002$; 95% confidence interval for the difference) and indirect energy curtailment behaviors ($t=7.56$, $p<0.001$) than those with no children under 12 years of age.

4.3.4. Presence of persons over 60 years old in the household

Household with persons over 60 years old conduct more indirect energy curtailment behaviors than those with no family members over 60 years old ($t=2.06$, $p=0.04$).

4.3.5. Gender of the HRP

Households whose HRP is female conduct more direct energy curtailment behaviors than those whose HRP is male ($t=-2.88$; $p=0.005$).

4.3.6. Age

People between the ages of 30 to 39 have the highest reported direct energy curtailment behavior. This bracket is, on average, 0.34 points higher than the "under 30" bracket ($F=11.69$; $p=0.000$; Post Hoc Scheffé $p=0.000$). People over 39 years old have the highest reported indirect energy curtailment behavior. This bracket is, on average, 0.55 higher than the youngest bracket ($F=37.05$; $p=0.000$; Post Hoc Scheffé $p=0.000$).

4.3.7. Family income

The second lowest family income bracket exhibits an average direct energy curtailment behavior that is 0.24 points higher than the second highest family income bracket ($F=4.38$; $p=0.005$; Post Hoc Scheffé $p=0.002$). For the conduct of indirect energy curtailment behavior, the second lowest family income bracket is, on average, 0.33 points higher than the second highest family income bracket ($F=8.60$; $p=0.000$; Post Hoc Scheffé $p=0.000$).

4.3.8. Education

No significant difference was observed between people with different levels of education for direct energy curtailment behavior. For indirect energy curtailment behavior, those with high school diplomas have the highest reported indirect energy curtailment behavior. This bracket is, on the average, 0.68 points higher than the highest education level bracket ($F=16.05$; $p=0.000$; Post Hoc Scheffé $p=0.000$).

The statistically significant variables in ANOVA were entered in OLS regression analysis to determine the interactive relationships between socio-demographics and direct and indirect energy curtailment behaviors separately. Generally, socio-demographics explain more variances of indirect energy curtailment behaviors than direct energy curtailment behaviors. Table 3 shows that females tend to buy "greener" products in their daily lives than males. Family structure variables also show statistically significant influence on direct or indirect energy curtailment behaviors. Specifically, households with children under 12 years old tend to conduct more indirect energy curtailment behavior. Households whose HRP is female tend to conduct more direct energy curtailment behaviors than those whose HRP is male. Older people exhibit more direct and indirect energy-saving behaviors than younger people. Low-income families tend to perform more direct energy curtailment behaviors than medium- to high-income families. Education negative influences indirect energy curtailment behaviors. Particularly, people with a master's degree or doctorate behave in a worse manner on their daily purchasing than those with low education level.

Table 3
Effect of socio-demographic factors on direct and indirect energy curtailment behavior.

Predictor	Model1 (Direct)	Model2 (Indirect)
Gender	/	0.142***
Marital status	0.070	0.022
Children under 12 years old in the household	/	−0.132*
People over 60 years old in the household	−0.014	−0.022
Gender of the household reference person	0.094*	/
Age_30–39	0.225**	0.198**
Age_over 39	0.119*	0.166**
Family income_2001–5000	−0.016	−0.012
Family income_5001–10,000	−0.162*	−0.087
Family income_over 10,000	−0.063	−0.048
Education_Senior middle school	/	0.023
Education_ Associate degree or bachelor degree	/	0.042
Education_ Master's or doctoral degree	/	−0.120+
R^2	0.067	0.187
Adjusted R^2	0.052	0.167
F	4.421***	9.342***

N=501. Standardized regression coefficients are shown.
All the nominal variables were transformed to dummy variables before the regression, and the reference categories for three nominal variables are: "Male" was used as the reference category of "Gender", "Married" was used as the reference category of "Marital status", "Yes" was used as the reference category of "Children under 12 in the household", "Yes" was used as the reference category of "people over 60 in the household", "Male" was used as the reference category of "Gender of the household reference person", "Age_under 30" was use as the reference category for "Age", "Under RMB 2000" was used as the comparison category for "Family income", "Junior middle school or below" was used as the comparison category for "Education".

*** $p<0.001$.
* $p<0.05$.
** $p<0.01$.
+ $p<0.1$.

5. Discussion

5.1. Result discussion

This study explores the direct and indirect energy curtailment behavior of Chinese urban residents, and subsequently examines the extent to which various psychological factors and socio-demographics are related to direct and indirect energy curtailment behaviors. Overall, the results indicate that people conduct more direct energy curtailment behavior than indirect energy curtailment behaviors. Moreover, the relationship between direct and indirect energy curtailment behaviors and psychological factors and demographic factors slightly differs.

By comparing the reported direct and energy curtailment behaviors, we observe that the direct energy curtailment behavior of Chinese urban residents is significantly higher than indirect energy curtailment behavior. The mean score for "choose products with simplified packaging" is 3.49, which is much lower than the mean score of "turn off the lights" (4.43). The percentage of respondents who said that they always "choose products with simplified packaging" (13.3%) is significantly lower than the percentage of "turn off the lights" (51.3), indicating that the residents have not realized the considerable potential of saving energy through indirect ways. Two other reasons can account for the relatively lower scores of indirect energy curtailment behavior. First, indirect energy consumption is not reflected in people's energy bills. Second, people consider other attributes, such as quality and appearance, more than the evident energy consumption level in choosing products. Therefore, residents must be provided with

more information and knowledge about saving energy through indirect ways.

As a pro-environment and economical behavior, energy curtailment behavior is significantly related to environmental responsibility, and energy curtailment attitude. People who have a positive energy curtailment attitude and stronger environmental responsibility exhibit more energy-saving behavior, not only directly but also indirectly. The influence of consumer value is rarely studied in the environment field. The high level of indirect energy-saving behavior of non-materialists may be due to their concern with the quality, appearance and etc. of the products. It shows no effect on direct energy curtailment behavior. However, energy curtailment may reduce the comfort of living to some extent, as found by researchers. The influence of those psychological factors on indirect behavior is stronger than that on direct behavior possibly because purchasing behavior involves a more conscious process and is not as habitual as the direct behavior. Thus, we could conduct more publicity and education campaigns to rebuild or enhance people's value, responsibility, and attitude for energy saving.

Lastly, we examine the effects of socio-demographics on direct and indirect energy curtailment behaviors. Females conduct more indirect energy curtailment behaviors than males, which conforms to the results of some previous researches on the effect of gender on environmental behavior (Prothero, 1990; Roberts, 1996, Schahn and Holzer, 1990). Yue (2014) pointed out that in traditional Chinese household, the majority of female learn more about the family energy consumption situation compared with males, so they tend to be more energy-saving in their daily life, which supports the result of our study. The gender of the HRP exerts an influence on energy curtailment behaviors, but only in direct ways. Possibly, the energy-saving habits or “greener” behavior in daily life of a female HRP influence other household members. As Thøgersen and Grønhøj, (2010) reported, the electricity-saving behavior of females at home sets a good example for their male household partners. The results for indirect behavior are more complicated because this behavior occurs outside the home and involves more personal preference for goods; thus, indirect behavior will less likely be influenced by others. For households with children, family members conduct more indirect energy-saving behaviors than those without children. As mentioned by McMakin et al., (2002), household members tend to behave pro-environmentally because of their determination to set a good example to children. With regard to the influence of age on energy-saving behaviors, some of western studies have found that there is a negative correlation between age and energy-saving behavior (Diamantopoulos et al., 2003; Grunert and Kristensen, 1994). However, Chan (1996) found that geographical and cultural differences may exist in the influence of age on energy-saving behavior. For example, young Canadians are more likely to buy environmentally friendly products, but it is not the case in Hong Kong. In Chinese context, the old generation has the habit of saving energy, which could be ascribed to the fact that they experienced difficult times after the World War II. As found in this study, the old generation demonstrates more energy-saving behavior than the young generation and consumes more “greener” goods. This result is consistent with that of the study of Sun (2006) in China, which should be considered as a reference when promoting people's energy conservation behaviors.

Previous research has shown that cost savings may be a main driver of energy-saving behavior (Brandon and Lewis, 1999; Downs and Freiden, 1983), which strengthens the importance of the effect of income on energy conservation (Martinsson et al., 2011; Park and Lee, 2013). In the present study, people with low family income exhibit direct energy curtailment behaviors more frequently than those with high income because curtailment helps in reducing their energy bills. For those with high income, other ways could be formulated to encourage them to save energy (e.g., emphasizing the connection between energy-saving behavior and high social esteem). With regard to the influence of education level on energy-saving behavior, most researchers have found that high education level would leads to the conduct of more energy-saving behaviors. By contrast, this study observed that people with high education level conduct significantly less energy curtailment behaviors in indirect ways. Zeng (2011) has studied the relationship between education level and income of Chinese residents through empirical analysis, the result proved that there was a positive correlation between the residents' educational level and their income. In addition, Wang (2014) found that, the total income of more educated labor force is statistically significantly higher than the labor uneducated or less educated. Thus, compared with people restricted by economic status, those with high level of education tend to be more extravagant in their energy consumption.

5.2. Limitations and future work

First, the above results were drawn from the responses to a questionnaire survey conducted in three cities located in the middle part of China. These results can help understand the behavior and the influences of the antecedents of people within these cities, but may not be representative of the entire nation. Although the overall distribution of the sample resembles the national statistics in many ways, the sampling method showed bias in some dimensions (e.g. the distribution of age and education level). More representative samples should be selected in future research. Second, this study measured people's reported energy curtailment behavior in a manner that is similar to those of most previous studies in this field. Therefore, the results of this study could not directly represent the real change of household energy use, and people may declare that they are “greener” if only to conform to the social norm. The gap between behavioral energy saving and real energy saving is a limitation of behavioral research. As real energy consumption is very complicated and determined by a number of antecedents, a completely random sample is not appropriate to the study of real energy consumption. Thus, we suggest controlling the building and household demographics of the sample followed by measuring the energy bill, to avoid the inaccuracy of self-reported behavior. Third, this research mainly focused on psychological factors that represent several important attributes of energy curtailment behavior. Other psychological factors (e.g., social norm, perceived behavioral control, and so on) were considered. In future research, the effects of these factors on direct and indirect energy curtailment behaviors should be examined. Fourth, although we determined different levels of energy curtailment behaviors among different socio-demographic groups, the internal reasons were mainly deduced by integrating the results of other studies. Future studies could identify the exact reason for the differences by improving the design of the empirical research.

Table A1
Measurement of constructs.

Constructs	Items	Cronbach's Alpha
Direct energy curtailment behavior	3	0.792
Indirect energy curtailment behavior	3	0.702
Consumer value	3	0.714
Environmental responsibility	5	0.753
Curtailment attitude	3	0.835

Table A2
Means, standard deviations, and correlations.

Constructs	Mean	SD	1	2	3	4	5
1.Direct energy curtailment behavior	4.15	0.767	0.829				
2.Indirect energy curtailment behavior	3.63	0.729	0.302***	0.785			
3.Curtailment attitude	4.573	0.546	0.296***	0.278***	0.876		
4.Consumer value	3.496	0.890	0.188***	0.287***	0.161***	0.799	
5.Environmental responsibility	4.223	0.581	0.335***	0.370***	0.546***	0.321***	0.720

*** $p < 0.001$.

6. Conclusion and policy implications

The results of this study indicate that residents' energy-saving behaviors are determined by both psychological and socio-demographic factors. Generally, indirect energy curtailment behavior is related to psychological and socio-demographic factors and is stronger than direct behavior. The two sets of socio-demographics that have significant effects are different for direct and indirect behaviors.

The theoretical contribution of this research lies in two aspects. First, this research extends the current energy-saving behavior research and contributes to the knowledge about Chinese urban residents' indirect energy curtailment behavior that has been seldom studied. This point has an important implication for further study on how people's consumption choices lead to a more sustainable direction. Second, the effects of socio-demographics have been systematically examined in the Chinese context, including both personal and household levels. Different results have been found on the effects of these socio-demographics (e.g., family income, age, and education background), and these results have been compared with those of western studies. The variations in the results may be ascribed to China's special social, cultural, and economic background. Therefore, this finding has enriched the empirical research on the influence of socio-demographics in the Chinese context on the one hand and provided an example for multi-cultural comparison on the other hand.

This research provides two main implications to policymakers. Residential consumption accounts for almost 50% of China's GDP, indicating that indirect energy saving has considerable potential in leading the change in the industry sector and in the subsequent reduction of energy use. Thus, the first implication pertains to the launching of more awareness and promotional activities to encourage residents to implement shifts in consumption through such actions as choosing less energy-intensive goods. This suggestion is in line with that of Poortinga et al., (2003), who underscored strengthening the importance of spreading knowledge and information for indirect energy consumption. Policy measures should aim at increasing knowledge about this type of energy use. The Chinese government and relevant organizations may develop a rating system for the embedded energy in everyday goods, and supermarkets could be encouraged to place labels indicating low embedded energy in the products to help consumers identify them. The production sector and the market will consequently be encouraged to pursue a “greener” direction. Furthermore, people's non-materialistic notions, curtailment awareness, and environmental responsibility should be enhanced to facilitate change in their behaviors.

When combined with the effects of socio-demographics, policy measures would be more effective when targeted at specific groups and specific behaviors. Thus, the second implication refers to designing policies and interventions specific to those who exhibit less energy curtailment behaviors. Moreover, policies should be combined with other mechanisms to achieve their goals. For those with high income, highlighting the connection between energy-saving behavior and high social esteem may be effective to encourage energy saving. Compared with people restricted by poor economic status, those with high level of education tend to be more extravagant in their energy consumption. This finding implies that the government should pay more attention to building the people's notion of energy saving and social responsibility in high education to achieve the energy saving goal for the entire population.

Table A3
Loading, composite reliability and AVE.

	Items	Loading	Composite reliability	AVE
1.Direct energy curtailment behavior	DB1	0.707	0.866	0.688
	DB2	0.786		
	DB3	0.972		
2.Indirect energy curtailment behavior	IB1	0.645	0.826	0.616
	IB2	0.856		
	IB3	0.837		
3.Curtailment attitude	CA1	0.903	0.908	0.767
	CA2	0.890		
	CA3	0.832		
4.Consumer value	CV1	0.767	0.908	0.767
	CV2	0.851		
	CV3	0.775		
5.Environmental responsibility	ER1	0.614	0.841	0.518
	ER2	0.617		
	ER3	0.826		
	ER4	0.831		
	ER5	0.677		

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Appendix

See Appendix tables A1–A3

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