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Satisfactions on Self-Perceived Health of Urban Residents in Chengdu, China: Gender, Age and the Built Environment

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Abstract: Self-perceived health is an important factor for assessing urban residents' satisfaction and quality of life. However, few have comprehensively investigated the impact of demographics, lifestyle and health awareness, indoor environment characteristics, and neighborhood features on self-perceived health. To fill this gap, we designed a framework using multivariable regressions to derive odd rations and to analyze the determinants of self-rated health, stratified into different sub-groups divided by gender, age, and neighborhood types. The study area is Chengdu, one of the most populous cities in western China. The results show that: (1) female respondents reported worse health, with household income level and marital status significantly affecting self-rated health; (2) elderly people reported the worst health, while unique factors affected only younger people (18–29 years old), such as gender, smoking, and indoor environment characteristics; and (3) different types of neighborhoods influence their residents' perception of health differently due to historical establishment, current population composition, and housing conditions. Our study provides new observations on neighborhood types, while agreeing with previous studies on the influences of gender and age. We contribute to the field by providing a more complex understanding of the mechanism by which people rate their own health, which is important for understanding the satisfaction of urban residents and the built environment in which they live.

Keywords: self-perceived health; satisfaction of urban residents; gender and age; neighborhood type; Chengdu

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1. Introduction

Self-perceived health is an important factor for assessing urban residents' satisfaction and quality of life [1,2]. Scholars have focused on social demographic variables, indoor environment characteristics, lifestyle, and health awareness to account for urban residents' satisfactions [3–7]. For demographic conditions, gender and age are the two most recognized factors. There are different determinants of self-perceived physical and mental health for women and men, and it has been found that older people often have worse perceived health ([3,8,9]. In addition, employment, income, and education also play important roles [10,11]. For lifestyle and health awareness, drinking, smoking, and the lack of physical activities often negatively impact health perception [10,12,13]. Regarding the indoor environment, badly adjusted indoor temperature, humidity, and ventilation can worsen the perception of health. Finally, health perception is also negatively influenced by

different conditions of neighborhood characteristics, especially regarding urbanity, as well as different types of housing [8,14–16].

Scant research has focused on the relationship between lifestyle and health perception in the Chinese context, especially in the western part of China, where rapid urbanization is still in progress. At the same time, evidence has proved that the changing built environment exhibited robust impact on urban residents' health conditions in various neighborhood typologies [17]. To fill the gap, this paper examines the determinants of health perception in different sub-populations in Chengdu, China, aiming to shed new light on this discussion by analyzing demographics and the built environment characteristics. We aim to contribute to the existing literature in two ways. First, we categorize both perceived health incentives and disincentives, such as neighborhood environment conditions, by population subgroups. Second, we discover a more nuanced explanation for the determinants of health perception to derive urban policies.

The rest of the paper is organized as follows: Section 2 reviews existing literature. Section 3 explains the methods applied, followed by the results section. The discussion section elaborates the determinants of self-perceived health. The conclusion section summarizes the contributions and proposes future works.

2. Literature Review

2.1. Social Demography, Lifestyle and Health Awareness, and Indoor Environment Factors

Demographic factors, such as gender, age, and education, are among the most frequently suggested determinants of perceived health ([18,19]. For example, scholars showed that women were more likely to consider a broader range of items, such as psychological factors, non-medical negative life events, or non-threatening life diseases, into their self-rated health responses than men [3,20]. Others argued that while the self-rated health of older age groups unsurprisingly decreased, this association was often not attributable to age, but to other factors, such as physical condition or socio-economic environment [12,21]. Similarly, researchers also suggested that people with less education and lower income also tended to be less positive about their health condition than others [22]. In the Chinese context, rural-to-urban migrants experience better health perception than rural residents [23]. Additionally, a national study showed that people who engage in work, have higher household income, socio-economic status, and social class, have no depression, and have good social ties often report good health [18]. Another national study also argued that income and education had great influence on self-rated health, while occupation was not a significant contributor, except for women in lower grade management and professional jobs [19]. Among Chinese elderly, previous studies showed that age, number of diseases, family and neighborhood relations, and rentage were significant predictors of self-perceived physical health.

Lifestyle factors are also frequently investigated. Smoking and a lack of physical activity in both the built and natural environment settings might correspond to negative perception of health ([7,13]). However, Ou et al. [24] reported that people who perceive themselves as unhealthy engaged in more physical activities than others. Dhingra et al. [25] found that higher perceived healthcare needs increased with health insurance coverage in Massachusetts, United States.

The indoor environment significantly influences both actual health outcomes and self-reported health status. Illnesses such as the sick-building syndromes, which includes non-specific complaints that may or may not result in a concerning health problem come from poor ventilation systems or poorly-adjusted temperature and humidity, and can result in greater stress and annoyance, thereby leading to less positive health status ratings [4]. Research in China showed that indoor air pollution from interior decoration, indoor dampness, and poor ventilation conditions were all causes for sick-building syndrome [26]. Controls over temperature, ventilation, and noise provide the occupants greater comfort.

2.2. Neighborhood Characteristics and Sub-Group Analysis

The neighborhood environment includes important factors for perceived health quality. The relationship between subjective neighborhood and health perception can be partially explained by loneliness, depression, and stress [27]. Different types of housing, associated with various conditions in indoor environment and community structure, also affect self-evaluated health differently. Studies in Switzerland [14] Scotland [28], and Japan [29] all suggested that people who did not live in private housing (such as social rented or private rented housing) had significantly lower self-reported health than people who lived in their own home.

In the Chinese context, relatively little attention has been paid to study the relative associations of self-rated health to different groups of individual and neighborhood environments, with the exception of a few [24]. Globally, sub-group analysis has been widely used in many research undertakings looking at different patterns of perceived-health determinants. Such analyses have led to findings such as the one showing that an association between income and health perception was stronger in urban environments [15]. Sub-group analysis can often give more room for results and discussions, and can help tailor policies that improve the perception of health for specific groups of subjects.

To obtain such information on self-perceived health, surveys are often applied to assess the respondents' perceptions of health by using a three-to-five points scale, rating from poor to excellent [30]. This type of self-rated assessment has been proven to be as good as or better than more specific health questions, such as those investigating functional abilities, chronic diseases, or prescriptive medication. Furthermore, self-perceived health can be predictive of a patient's chronic disease, functional decline, or even mortality [14]. While this type of health assessment can become a good predictor for overall health status of the whole population, it may be influenced by other factors, such as demography, living environment, social network participation, and psychological state; therefore, separate evaluation for different groups is necessary and requires cautious attention [14,31]. Investigating the relationship between self-reported health and the outside factors is crucial for providing adequate responses to a patient's own understanding of their suffering and healing processes, thus promoting well-informed public decisions.

2.3. Determinants of Resident's Health Perception in the Chinese Context

In China, there is relatively little research focusing on the relationship between lifestyle and health perception, except for some investigations on the effect of smoking [32] and physical activities [24]. Moreover, most of the studies focus on large coastal cities, such as Beijing and Shanghai. Regarding the neighborhood built environment, also in the Chinese context, Liu et al. [33] suggested that the built environment had stronger ties to self-rated health than the natural environment, yet these relationships were relatively weak in comparison to the results from both Japanese and South Korean contexts. Seniors with living arrangement concordance, whether institutionalized or community-resided, reported better health, while people living in public subsidized housing were more likely to report poor health [17].

On the other hand, research has frequently investigated the socio-economic-political conditions of different types of Chinese housing. Traditional housing in China, such as Beijing's courtyard houses (hutong) and Shanghai's lane houses (lilong), are frequently discussed in literature, yet cities like Chengdu do not seem to have their own typical vernacular housing. One example is the Kuan Zhai Xiangzi—the old city where Qing dynasty's bureaucrats lived and worked, which was recently renovated to become a tourism site, yet still allows working-class families to stay and foster the community [34]. During the construction boom and urban regeneration in the 1990s, many traditional housing establishments in Chengdu and elsewhere were transformed into new housing with higher density and larger dwellings [35]. Work-unit (danwei) is the planned concept of welfare-oriented rental housing in China, and is representative of China's nationalized urban housing process. It has many socio-economic-political and spatial implications

for Chinese urban transformation (Bjorklund, 1986), yet is currently diminishing [36]. Many of the original residents have moved out, and the ones entering are mostly rural household registration, or *hukou* in Chinese; holders who want to find a cheap temporary location [37], thus reducing the social cohesion of work-unit neighborhoods significantly [8]. Many of these middle-income socialist workers are then transferred from the work-unit to proprietors of gated-communities [38], which emerged under the localization of governance and privatization of housing in China late 1980s [39]. This "gateness" existence enhances the residence's sense of safety and security, but does not necessarily provide a sense of community [40]. Finally, relocated housing was born out of the rapid expansion of cities, which led to urban land development and land use transformation. These housing units, often free and sometimes low-cost yet involuntary for relocated families, sometimes create tension and conflict over the process of residential relocation [41].

2.4. Research Gap

This study intends to fill these literature gaps by analyzing the determinants of perceived health in different sub-groups stratified by gender, age, and neighborhood type. The gender and age sub-groups were chosen for evaluation due to their frequent appearance as determinants for self-perceived health in other research [3]. Additionally, neighborhood type is a key indicator of the built environment, as well as socio-cultural settings that might house different groups of people. This paper is concerned with the different determinants that affect the residents' health perception in four common housing types in China: traditional, work-unit, gated community, and relocated housing [42].

Our hypothesis is that age, low-quality living lifestyles and indoor environment factors adversely will impact self-rated health, while gender and different neighborhood characteristics will affect perceived health differently. Moreover, we also hypothesize that the composition of determinants influencing self-rated health would be different for different sub-groups; in particular: worse indoor environments will lead to worse perceived health for younger people due to their presumably higher amount of time spent indoors; women will have worse-rated health in the presence of factors causing psychological stress; and having rural *hukou* might negatively impact residents of relocated housing due to its temporariness.

3. Methodology

3.1. Study Area and Data Collection

The study area of Chengdu is shown in Figure 1. Chengdu is the capital city of Sichuan Province and is one of the most populous cities in western China. There have been major policies meant to improve the quality of life and access to public service of low-income residents from the city government [43]. The healthcare system is generally heterogeneous; a study showed that approximately 90% of the population in only 57% of the city area have access to all three levels of healthcare within an acceptable amount of time [44]. Chengdu is located in one of the largest regions affected by haze in China [45], and over the 2014–2016 period, the average annual concentration of PM10 and PM2.5 in the city was 1.5–2 times higher than the Chinese National Ambient Air Quality standard, and 5–7 times the standard of World Health Organization (WHO) [46].

The research design is illustrated in Figure 2. The Chengdu Health Survey (CHS) data used in this study was collected in 2016 by the Harvard–China Project at Harvard University and Peking University, and covered most of Chengdu's urban area except for the newly developed Tianfu New District [47]. Using Primary Sampling Unit (PSU) as the spatial grid, 40 neighborhoods were selected. The health survey included questions grouped into four categories: Demography (gender, age, education, *hukou*, income, employment), Lifestyle and Health Awareness (smoking, exercise, health insurance, knowledge of asthma, willingness to pay for asthma treatment), Indoor Environment (cooking fuel, natural ventilation, air conditioning, indoor smoking), and Neighborhood Environment (building condition, neighborhood type, sidewalk). For example, the question for air quality perception is "*Do*

you think the average air quality in Chengdu is . . . ?" and the answers are ranked on a scale of 1–5, with 1 being "very good" and 5 being "very bad." Similarly, for the question about perception of health, all responses are Yes/No polar questions (such as asthma condition, smoking and second-hand smoking, cooking methods, ventilation, sidewalk), with 0 being "No" and 1 being "Yes". A more detailed list of questions used in the survey is attached in Supplementary List S1.

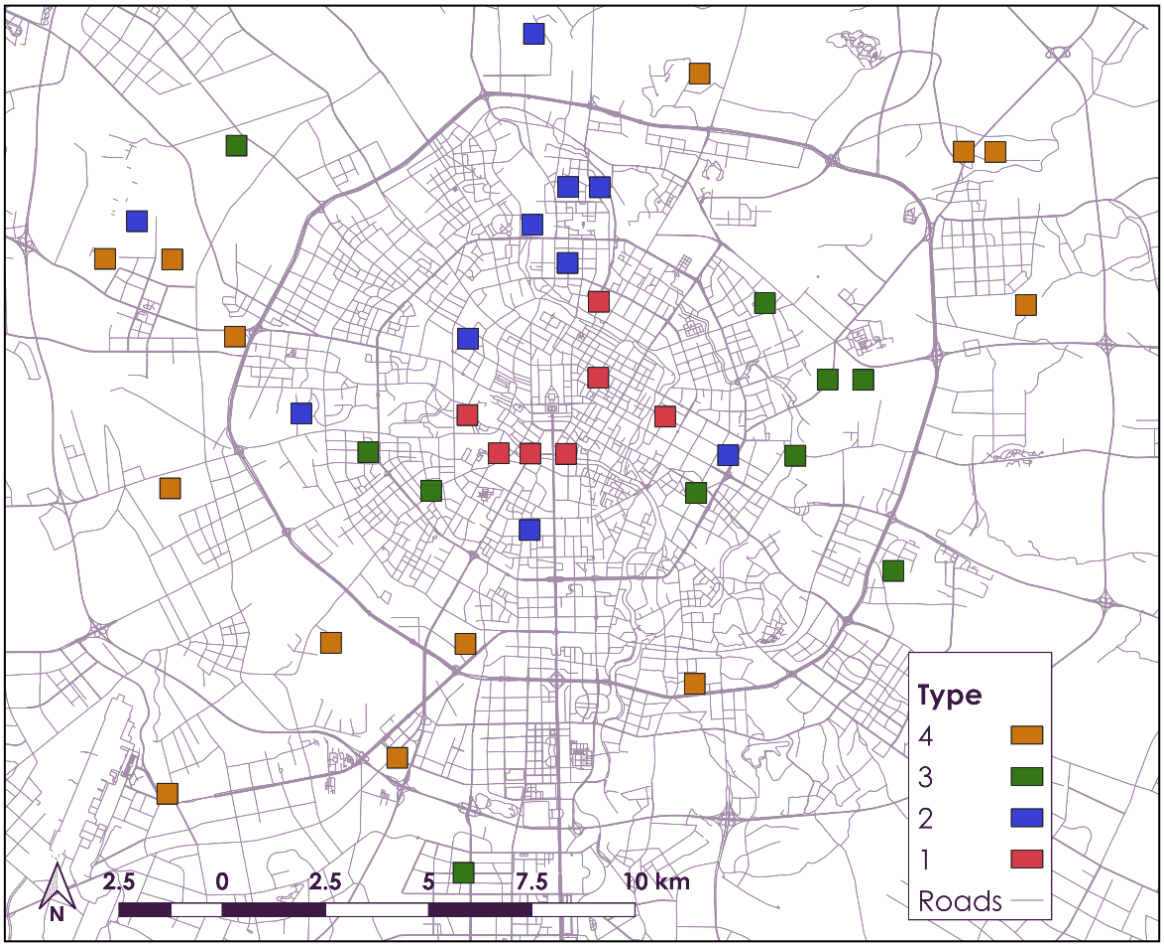

Figure 1. The locations of 40 selected neighborhoods in Chengdu, China.

3.2. Statistical Analysis

The data analysis aims to identify significant independent variables with different distributions across the sub-groups that influence the self-rated health of each sub-population. Independent variables were sorted into four categories (demography, lifestyle and health awareness, indoor environment, and neighborhood environment), then, regression analysis was run independently for the total population and for sub-groups stratified by gender, age, and type of neighborhood.

Data was analyzed with RStudio Version 1.2.1335. The data selected to run regressions were either numerical or binary (Yes/No, or Male/Female for gender). Percentage, mean, and standard deviation, with some descriptions by sub-groups of gender, age, and neighborhood type are provided in Supplementary Tables S1 and S2. ANOVA test was run in order to determine whether the differences between sub-groups were significant. For the ANOVA test, our null hypothesis was that the mean of each group in our sample (that share the same value for the testing parameter) was equal and the variance existed only due to chance.

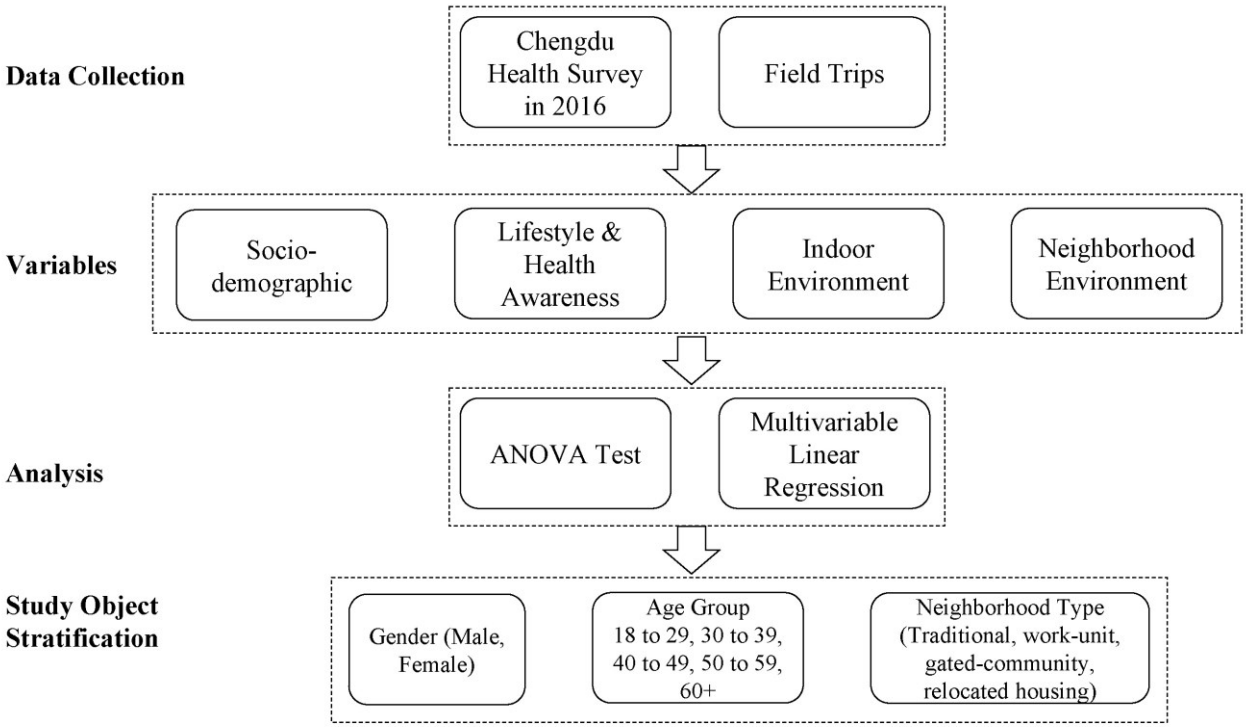

Figure 2. Research design.

The test statistic for testing is:

$$F = \frac{\sum n_j \left(\overline{X}_j - \overline{X}\right)^2 / (k-1)}{\sum_j \sum_i \left(x_{ij} - \overline{x}_j\right)^2 / (n-k)}$$

and we reject the null hypothesis if $F \geq 3.24$.

Additionally, multivariable linear regression was performed to estimate the perception of health, and other models were also tested for the whole population and for each subgroup. Odds ratio and 95% confidence interval were estimated and reported for each risk factor. The regression model's formula for the dependent variable Y is:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_\rho X_\rho + \sigma(Y)$$

$$sd(Y) = \sigma\left(independent\ of\ X's\right)$$

where β_0 is the intercept; $\beta_1, \ldots, \beta_\rho$ are regression coefficients, and σ is the residual standard deviation. Here, we do the test for significance of regression, first by computing the t-statistic and p-value:

$$t_{stat} = \frac{\hat{\beta}_j - \beta_{j,0}}{SE\left(\hat{\beta}_j\right)}$$

$$P_{value} = 2\Phi(-|t_{stat}|)$$

where $\hat{\beta}_j$ is the expected value of β_j. Again, we reject the null hypothesis if the p-value is smaller than the significant level α. Finally, the 95% confidence interval for β_j is:

$$\left[\hat{\beta}_j - 1.96 \times SE\left(\hat{\beta}_j\right),\ \hat{\beta}_j + 1.96 \times SE\left(\hat{\beta}_j\right)\right]$$

4. Results

Our hypothesis is partially supported by the results. In terms of gender, we confirmed that females reported worse self-perceived health. We also observed that a longer time

spent living in Chengdu, men without Chengdu *hukou*, and unmarried women living in low-income households showed negative correlations to health. In terms of age, elderly people reported the worst health. There are unique factors affecting only younger people (18–29 years old), such as gender, smoking, and indoor environment characteristics. In addition, some built environment factors, such as having sidewalks, only have a significantly positive impact towards self-rated health for people aged 30–39. Moreover, no factors significantly affect the self-rated health condition of more than two age groups. In terms of neighborhood type, we confirmed that different factors, such as historical establishment, current population composition, and housing conditions affected the perception of health in the four types of neighborhoods differently. Unexpectedly, we found that while having rural *hukou* in traditional housing significantly corresponds to better health perception, it reduces the odds in relocated housing.

4.1. Statistical Summary of Variables

In the 2016 CHS, a total of 1065 valid responses were collected. After eliminating incomplete answers, a total of 881 valid responses were recorded, comprising 450 men and 431 women. Supplementary Table S1 shows the statistical summary of variables, marked with significance levels from one-way ANOVA test. According to Table S1, men reported significantly better perception of health than women (2.69 vs. 2.94). The average age of respondents was 43.55 years old. Men had longer education than women, with an average of 10.49 years of schooling compared to 9.38 years. They were also more likely to be currently employed (76.9% vs. 60.1%), had a higher chance of getting injured at work (2.82 vs. 2.44), and were not currently married (29% vs. 22%). The households of male respondents also reported a higher average income (2.23 vs. 2.06), less cooking time (1.86 vs. 2.11 h), and rarer use of electricity for cooking (30% vs. 37%). The vast majority of smokers were men (65% of the male responders were smokers, while only 5% of women were), and they also reported a higher percentage of smokers in their household.

The variables also differ by age groups. There are some obvious factors that are directly related to age group, such as years spent living in Chengdu, having Chengdu *hukou*, rate of employment and retirement, as well as duration of working. Younger people (aged 18–29) had a significantly smaller marital rate of 31.4%, while all the other age groups were about 88% married. Younger people also tended to have longer time for education. Fewer people in the group of 60+ years old had rural *hukou* (25.6%). Rate of health insurance ownership significantly increased with age, while self-rated health worsened. People in the age 60+ group exercised more, and their households also often had longer natural ventilation and less air conditioning. Cooking time also varied across age groups, as well as fuel use: the 40–49 and 50–59 age groups used liquefied petroleum gas (LPG) more.

Neighborhoods of traditional housing recorded the lowest percentage of respondents having rural *hukou*, 36%, while relocated housing had the highest percentage, 47%. People living in traditional housing were also more likely to be single (64%, in comparison to 76%, 76%, and 78% in the three other neighborhood types, respectively), yet were also more likely to be currently employed (73.8%, vs. 67.0%, 64.7%, 70.2%). Health perception was reported to be highest among residents of a work-unit, then traditional housing, relocated housing, and gated-community (2.63, 2.73, 2.89, and 2.95, respectively), this is also the same order reported for daily natural ventilation (14.15, 15.16, 17.09, and 18.57 h). The use of different types of fuel and the height of buildings also differed significantly among the neighborhood types.

4.2. Self-Perceived Health Conditions by Gender and Age

Table 1 summaries the survey responses by gender. It shows the odd ratios and confidence intervals of self-perceived health of the total population by gender, while Supplementary Table S3 shows the corresponding linear regression coefficients and *p*-value. Gender itself is significantly correlated to health perception, where females often reported worse health (OR: 1.228; 95% CI: 1.061–1.421). Age and air-quality perception are strongly

correlated to the whole population and both sexes, with higher quality of health rated by younger people, and correlated to higher air quality. A longer time spent living in Chengdu also resulted in worse health perception for males, as well as for the entire population. However, men without Chengdu *hukou* correlated to worse rated health. Women who lived in households with lower income levels or were not married reported worse health. Considering the total population, having insurance, smoking in the household, and longer time with natural ventilation negatively correlated to health, while having an air conditioner at home affected self-rated health positively.

Table 1. Odd ratio and confidence interval of self-rated health perception by gender.

	All			Male			Female		
	OR	**2.50%**	**97.50%**	**OR**	**2.50%**	**97.50%**	**OR**	**2.50%**	**97.50%**
Demography									
Gender	1.228 **	1.061	1.421						
Age	1.023 ***	1.015	1.032	1.022 **	1.008	1.035	1.026 ***	1.014	1.038
Years living in Chengdu	1.005 *	1.000	1.009	1.010 **	1.004	1.017	1.001	0.995	1.007
Years of education	0.988	0.975	1.001	0.990	0.976	1.005	0.977	0.951	1.004
Rural hukou	1.047	0.890	1.232	1.102	0.872	1.392	0.988	0.782	1.247
Chengdu hukou	0.856	0.724	1.013	0.769 *	0.604	0.980	0.934	0.735	1.188
Household income level	0.927	0.823	1.044	1.050	0.894	1.234	0.796 *	0.661	0.950
Chance of getting injured at work	1.007	0.983	1.030	0.994	0.962	1.026	1.027	0.991	1.064
Years of working	0.999	0.991	1.008	0.998	0.985	1.012	0.995	0.985	1.006
Martial status	0.888	0.765	1.030	0.973	0.788	1.201	0.797 *	0.641	0.991
Household size	1.011	0.966	1.059	0.980	0.916	1.050	1.038	0.974	1.106
Lifestyle and Health Awareness									
Air quality perception	1.168 ***	1.097	1.244	1.191 ***	1.091	1.301	1.149 **	1.047	1.260
Smoking	0.921	0.769	1.105	0.880	0.643	1.204	0.913	0.639	1.306
Hours of weekly exercise	0.993	0.985	1.001	0.997	0.986	1.008	0.990	0.977	1.002
Health insurance	1.181 *	1.006	1.387	1.135	0.902	1.429	1.259	1.000	1.586
Familiarity to asthma	1.048	0.981	1.120	1.033	0.943	1.130	1.048	0.947	1.160
Willing to pay for asthma treatment	1.006	0.897	1.127	0.996	0.847	1.172	1.065	0.903	1.256
Daily cooking time in family	0.998	0.946	1.054	0.984	0.910	1.065	0.984	0.911	1.064
Indoor Environment									
Fuel use—LPG	0.875	0.685	1.118	1.014	0.711	1.445	0.788	0.553	1.124
Fuel use—natural gas	1.117	0.906	1.376	1.323	0.986	1.776	0.984	0.716	1.353
Fuel use—electricity	0.939	0.825	1.068	0.923	0.767	1.112	0.938	0.780	1.128
Fuel use—coal	1.077	0.729	1.593	0.774	0.410	1.461	1.263	0.762	2.092
Hours of daily natural ventilation	1.013 ***	1.005	1.020	1.018 **	1.007	1.029	1.008	0.998	1.019
Air conditioner	0.844 *	0.740	0.962	0.830	0.687	1.002	0.892	0.738	1.078
Smoking in household	1.223 *	1.053	1.421	1.299	0.933	1.808	1.228 **	1.022	1.474
Neighborhood Environment									
Sidewalk in front of building	0.894	0.699	1.142	0.862	0.621	1.198	0.991	0.676	1.453
Building condition	0.973	0.908	1.042	0.986	0.895	1.087	0.973	0.878	1.079

Note: Significant levels * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 2 shows the odd ratios of self-rated health by age groups, while Supplementary Tables S4 and S5 show the corresponding confidence intervals, coefficients, and *p*-values. There were no factors that significantly affected the self-rated health condition of more than two age groups. Only in the 18–29 age group, females had higher odds of reporting worse health conditions, while more education corresponded to better reported health in only the 40–49 age group. Air quality perception and exercise only positively corresponded to health perception in the 60+ age group, while smoking was negatively correlated to younger people aged 18–29 and cooking time to the 50–59 age group. The indoor environment seems to have the most significant impact towards the 18–29 age group, when better perceived health strongly corresponded to using electricity for cooking, not using coal for cooking, less natural ventilation, and not experiencing smoking in households. However, the use of electricity for cooking significantly increased the odds of reporting poor health for the 60+ age group. Having sidewalks only had a significantly positive impact towards self-rated health for people aged 30–39.

Table 2. Odd ratio of self-rated health perception by age group.

OR	Age 18–29	Age 30–39	Age 40–49	Age 50–59	Age 60+
Demography					
Gender	1.351 *	1.032	1.142	1.366	1.173
Years living in Chengdu	1.006	1.003	1.003	1.01	1.004
Years of education	1.012	1.004	0.950 *	0.96	0.973
Rural hukou	0.945	1.11	0.722	1.467	1.137
Chengdu hukou	0.852	0.932	0.757	1.151	0.685
Household income level	1.101	1.076	1.017	0.706	0.928
Chance of getting injured at work	0.994	1.019	1.004	1.023	1.016
Years of working	1.005	1.004	0.985	0.995	1.01
Martial status	0.992	1.162	0.6	0.75	0.86
Household size	1.015	0.941	0.965	1.09	0.989
Lifestyle and Health Awareness					
Air quality perception	0.98	1.154	1.139	1.134	1.401 ***
Smoking	0.692 *	0.777	0.991	1.295	1.005
Hours of weekly exercise	0.991	0.984	0.99	1.017	0.977 *
Health insurance	1.268	1.099	1.136	1.206	0.965
Familiarity to asthma	1.111	1.004	1.074	1.035	0.95
Willing to pay for asthma treatment	1.004	0.965	0.905	1.066	1.131
Daily cooking time in family	1.025	1.018	1.035	0.872 *	1
Indoor environment					
Fuel use—LPG	0.661	1.251	0.68	0.849	1.085
Fuel use—natural gas	0.912	1.632	0.615	1.696	1.505
Fuel use—electricity	0.685 ***	0.905	0.908	0.995	1.470 *
Fuel use—coal	2.582 *	0.479	0.727	0.89	1.113
Hours of daily natural ventilation	1.023 ***	1.013	1.009	1.031 **	0.981
Air conditioner	0.821	0.944	1.007	0.906	0.969
Smoking in household	1.316 *	1.404	1.086	0.876	1.449
Neighborhood environment					
Sidewalk in front of building	0.691	0.500 *	1.256	1.263	0.68
Building condition	1.057	0.997	0.968	0.932	1.057

Note: Significant levels * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

4.3. Self Perceived Health Conditions by Neighborhood Type

Table 3 shows the odd ratios of self-rated health by each neighborhood type, while Tables S6 and S7 show the corresponding confidence intervals, coefficients, and *p*-values. Different factors affected the perception of health in the four types of neighborhoods differently. For people living in traditional housing, more education, having Chengdu *hukou*, having an air conditioner, and living in worse condition buildings gave higher chances of feeling good health. Residents of work-units with higher income levels, fewer years spent working, and more physical exercise had a higher chance of feeling good health. Residents of gated-communities who did not using LPG as cooking fuel or experience smoking in their household had higher odds of having lower health conditions. Residents of relocated housing who are females, lived in Chengdu for a longer period of time, and had health insurance had higher odds of having lower health conditions. Older age correlated to worse self-rated health in all types of housing except traditional, with a close range of odd ratio and confidence interval. Lower self-rated air quality generally correlated to lower self-rated health, with a significant relationship to work-unit and gated-community. Interestingly, while having rural *hukou* in traditional housing significantly corresponded to better health perception, it reduces the odds in relocated housing.

Table 3. Odd ratio of self-rated health perception by neighborhood type.

OR	Type 1 (Traditional)	Type 2 (Work-Unit)	Type 3 (Gated-Community)	Type 4 (Relocated Housing)
Demography				
Gender	0.924	1.188	1.119	1.452 **
Age	0.999	1.023 *	1.025 *	1.024 **
Years living in Chengdu	1.01	0.998	1.006	1.008 *
Years of education	0.917 ***	0.992	0.998	0.992

Table 3. *Cont.*

OR	Type 1 (Traditional)	Type 2 (Work-Unit)	Type 3 (Gated-Community)	Type 4 (Relocated Housing)
Rural hukou	0.611 *	0.746	1.313	1.475 **
Chengdu hukou	0.442 ***	0.844	1.236	0.962
Household income level	1.174	0.750 *	1.068	0.974
Chance of getting injured at work	0.976	1.02	1.018	1.004
Years of working	1.012	1.018 *	0.989	0.994
Martial status	0.785	1.041	0.742	0.987
Household size	1.067	0.923	1.071	0.99
Lifestyle and Health Awareness				
Air quality perception	1.09	1.295 ***	1.218 *	1.058
Smoking	0.885	1.054	0.723	0.987
Hours of weekly exercise	1.004	0.975 *	0.99	0.999
Health insurance	0.927	0.96	1.2	1.358 *
Familiarity to asthma	1.09	0.934	1.135	1.005
Willing to pay for asthma treatment	1.008	1.205	0.87	0.925
Daily cooking time in family	1.076	1.025	0.934	1.013
Indoor environment				
Fuel use—LPG	1.316	1.041	0.448 *	0.949
Fuel use—natural gas	1.228	1.14	0.733	1.297
Fuel use—electricity	0.94	1.155	1.169	0.798
Fuel use—coal	0.432	1.572	0.569	0.858
Hours of daily natural ventilation	0.983	1.011	1.021 *	1.016 *
Air conditioner	0.670 *	0.905	0.889	0.904
Smoking in household	1.216	1.037	1.426 *	1.068
Neighborhood environment				
Sidewalk in front of building	0.631	0.584	0.927	1.372
Building condition	0.824 *	0.973	1.03	1.056

Note: Significant levels * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

5. Discussion

In this study, we found evidence supporting the idea that health perception is strongly correlated to demographic factors, such as gender and age, which is in agreement with previous studies [3,19,48]. We also found that neighborhood type also provides a significant influence on health perception. The following discussion is stratified into the different sub-groups of gender, age, and neighborhood type.

5.1. Health Perception and Gender

The higher odds of rating worse health by women in this study might be due to the difference in labor, as argued by previous studies; women are more likely to work part-time, have lower income and more economic hardship, and do more unpaid domestic work, all of which might be directly associated with poor health. The Chinese national survey in 2010 also provided evidence that the majority of working women were in the low-paid agriculture sector and had lower educational levels [19]. This gender discrepancy could also be explained through the well-studied argument that women are much more cautious: they often invested more in self-care and health services, and requested more health information; they also considered actions leading to health risks, such as smoking, drinking alcohol, speeding, or breaking traffic laws to be significantly more severely negative than men [49].

Other studies have shown the different determinants of self-rated health among men and women. It was suggested that psychological factors, such as symptoms of depression and loneliness, affected women's perceived health [3], while age and financial stability affected men's [50]. However, the data in this study showed that age has a stronger impact on the self-rated health of women than of men. First, older women often have relatively less education, are more likely to be widowed, and have a higher burden of chronic diseases [48]. Second, women are more worried than men, especially in regards to age and healthcare. This also explains why having smokers in a household only negatively affects perceived health in women, not in men, despite the data showing that men themselves smoke much more often than women.

Furthermore, this study shows that household income level and marital status are significant factors only for women. In order to explain these observations, we need to provide some social context. China has a strong patriarchal tradition, and nowadays, there is great social pressure for women to get married; older, single, and often highly educated women are highly stigmatized by the widespread use of the derogatory term "leftover women" (*shengnu*) [51,52]. Moreover, income inequality between men and women is prevalent [53]. Therefore, single women have a lower average household income per person. Men also receive more intergenerational transfer and inheritance, while single women can rarely secure their own assets, which forces women to seek ways to co-own homes with their spouse [54]. These financial strains and psychological burdens are not only experienced by single women, but also by married ones. The 2016 Women Financial Management Report showed that 60% of Chinese women control and manage their family's finances [55]. Although more and more young, urban, or migrant husbands are sharing these responsibilities, Chinese married women still bear many household responsibilities, such as childcare and chores, while keeping up their own profession and experiencing a significantly larger wage gap than single women [56]. This social and financial instability often causes women more stress, thus worsening their health perception. These are some possible explanations for why income and marital status affect women's self-rated health. Since women often have lower income, yet experience a stronger impact of income on perceived health, income is a "counterforce (The concepts of "force" and "counterforce" are used: a population having higher "force" A would also positively associate perceived health with A more than the other population, and vice versa; those who have higher "counterforce" B would have B correlated more negatively than the other population (similar to opposite signs). A factor can be either "force" or "counterforce," but cannot be both)" for health perception in this situation.

Meanwhile, for men, having Chengdu *hukou* corresponds to better perceived health, yet a longer time spent living in Chengdu gives a negative impact. To be clear, having Chengdu *hukou* is not similar to an urban *hukou*—which is often the approach while talking about regional inequality in China. The mechanism for why Chengdu *hukou* and living duration make such an impact on men's health perception would need further research. Good air quality perception also increases the odds of reporting good health in men more than in women, which can be explained by the rate of employment in men being higher, as shown in Table S1. This means more men are going to work, thereby having a higher chance of getting exposed to traffic and industrial pollution.

5.2. Health Perception and Age

Our explanations on why older people (age 60+) have worse perception of health includes direct reflection of their actual physical health conditions and their health concerns —portrayed by higher rates of attaining health insurance (Table S1). Table S1 also shows that older people exercise substantially more than any other age group, which may partly be due to their health concerns, but also may be due to the greater availability of free time as they retire. The strong association between physical activities and perceived health in the elderly might come directly from spending more time doing them [57], but might also be from the environment where they conduct the activities. Older people rarely use indoor gymnasiums, rather, they utilize the outdoor environment, such as walking in parks and other green spaces. Studies have suggested that greater amounts of green and blue space are positively correlated to perceived general health and that frequently visiting favorite sites can generate energetic and healthy feelings [58]. This relationship between physical activities in the outdoor space might also explain why air quality perception significantly correlates to health perception among older people only.

On the other hand, there are unique factors that are only associated with the self-rated health of the youngest group (aged 18–29). For example, gender has significant association with this group, who are also reported to have a large single population. This supports the result from the previous section regarding the low rated health of single women, possibly

from their stress level and their tendency to make their mental health a determinant of perceived health. Additionally, the indoor environment is most strongly associated with health perception among younger people, who often grew up in households with modern amenities, including clean fuels (such as electricity) and air conditioners. The appearance of these appliances gives them the sense of sanitation, hygiene, and comfort, thus, without them, young people might feel uneasy or unwell. This group also associates smoking and secondhand smoking to bad health more than any other age group. Having more education, as well as more exposure to media and propaganda, younger people have a better understanding about the negative impact of tobacco smoke. For example, a case study in Scotland shows the elasticity in their usage, when younger people can easily move both in and out of smoking [59].

5.3. Health Perception and Neighborhood Type

In this study, we found that having rural *hukou* has a significantly opposite impact on perceived health between residents of traditional housing (positive) and relocated housing (negative). The negative impact of having rural *hukou* on perceived health in relocated housing is confirmed by previous studies [60]. However, the opposite association for traditional neighborhoods might be explained by their bifurcated population, as revealed by the largest standard deviation of age (Table S2). Those who hold rural *hukou* are young, with relatively good health, while those who hold urban *hukou* are mainly elderly and relatively poor. The younger generations from traditional neighborhoods have left for other employment opportunities, and the economically advantaged have moved away to better residential areas, which is supported by the lowest percentage of rural *hukou* in these neighborhoods among four types (Table S2). Those left out are generally incapable of moving or are emotionally attached to the neighborhoods where they lived for most of their lives. The population bifurcation does not exist in other neighborhood types.

For residents living in traditional housing, the group has the lowest household income level and rate of Chengdu *hukou*, but the highest percentage of unmarried population. Figure S1 shows a typical traditional housing neighborhood. Furthermore, education and Chengdu *hukou* status are significant factors for this group only. A previous cohort study showed that this effect of education on health can be strongly explained through income by both education-induced income difference and income-induced health vulnerability [61]. However, more research is needed to explain why this is only significant for traditional housing in Chengdu, or whether there exists any other explanation for the relationship between education and perceived health in this group. The restriction of *hukou* for buying properties, getting jobs, as well as gaining other social benefits in Chengdu might affect unmarried people with non-Chengdu or rural *hukou*, thus creating a psychological burden. Finally, there is also a significant positive influence of air conditioners and good building conditions on the self-rated health of residents living in traditional housing. As traditional housing is often the target for either constant renovation or demolition, good building condition and modern appliances, such as air conditioners, are signifiers of residential stability for the occupants, thus, these signifiers might cause a positive impact on their psychological state. On the other hand, renovation is also a significant source of noise and dust, causing disturbance that directly affects the residents' physical and perceived health [62].

Residents in work-unit neighborhoods are the only population whose health perception is affected by income level among all types, where more household income increases their self-perceived health. Notably, they have the second-lowest rate of employment and the highest rate of retirement, yet there is no significant difference in the mean and standard deviation of age compared to other types of neighborhoods (Table S2). In order to explain the employment pattern of work-unit, it is necessary to consider its development history. When established, work-unit neighborhoods mainly served employees of state-owned or collectively owned enterprises, as well as government departments or institutions, thus directly containing the sources of employment [37]. Then, after the urban market transition,

many of these employers collapsed, leaving those who remained either poor or aged, and the new incomers were mostly rural migrants or low-income households [63]. Thus, there exists a sense of high financial insecurity among the work-unit residents, not only because of low income, but also due to uncertainty about the future, which subsequently negatively affects their health perception. Their health perception also worsens as their years spent working increase, yet they are the group with smallest working history among all four types of neighborhood—this might be directly related to their age distributions. Nevertheless, despite all of the unstable circumstances, residents living here also have the most positive average health perception, relatively. A research of Nanjing showed that living in these neighborhoods is significantly associated with good accessibility and socialization space, especially for the elderly, as the ties with co-residents are strong when you share the same workplace nearby [64].

Gated-communities share a much stronger correlation between air quality perception and health perception with residents in work-units. The health conditions of gated-community residents also experience a strong influence from indoor tobacco smoke. Meanwhile, natural ventilation is a significant consideration for both gated and relocated housing neighborhoods. According to Table S2, households in gated-communities have a significantly longer time of daily natural ventilation (the second-longest is for relocated housing), which directly helps explain other observations.

Finally, only in relocated housing neighborhoods, gender has a strong correlation to health perception. As previously suggested, women are more often in charge of family financing and housing relocation than men in China. The processes are often lengthy, energy-consuming, and stress-inducing [41]. A similar study on relocated housing in Shanghai showed that lower income households are disproportionately affected by relocation because of housing cost, accessibility, job loss, and disposable income [65]. Thus, it is possible that women in these neighborhoods experience more negative impacts on their perceived health. Furthermore, residents' perceived health in these neighborhoods is also positively correlated with amount of time spent living in Chengdu and the possession of health insurance. These might be explained by the relative stability in social conditions, considering the precarious nature of the relocation process.

6. Limitations and Future Study

Future research could address certain limitations in this study. Firstly, all of the data are empirical, taken from a survey of selected populations. Other measures, such as official health incidents report, biomarkers, long-term mortality outcomes, air quality and other lifestyle factors recorded, or housing inspections to examine the indoor environment, could provide useful validation to self-rated health. In addition, the cross-sectional design limited our investigation to one point in time. We plan to conduct another round of surveys so that we can produce panel data analysis to address the complexity of the self-perceived health of urban residents.

Secondly, most of the environmental measures considered are related to the home. Including factors related to traffic and working settings would give a broader and more complete picture of how perceived health changes through the environment.

Thirdly, we chose to limit the statistical analysis to attribute and characteristic data, while not considering any spatial components. Aspects such as spatial clustering, traveling time, relationship to infrastructure and public amenities, and the use of other modeling methods might indirectly impact the residents' perceived health. For example, the smooth difference-in-differences (DID) model, which includes a transition function to control gradual effects on treatment groups [66], the grey spatial temporal forecast model, which examines the spillover effects [67], and the dual comprehensive clouds method, which can assess the risk of certain diseases [13], to name a few.

Finally, even though the rate of surveys without response is low, there are still chances for bias, as well as the fact that parameters such as the use of coal as cooking fuel and the

presence of sidewalks in front of buildings have a very small rate of prevalence, which would require a bigger sample size to minimize bias.

7. Contribution and Conclusions

This study contributes to the existing literature in several ways. First, by analyzing different population sub-groups, some factors affecting the perceived-health disincentives were discovered: the group earning a lower income often experiences a strong association of income to perceived health (particularly women). On the other hand, some perceived-health incentives also need more attention: people experiencing better air quality often correlate their air quality perception to health perception (men and older people); the group spending more time on physical exercise would claim a stronger influence of exercise on self-rated health (60+ year-old people); the indoor environment has a strong impact on younger people who spend more time indoors; the use of clean energy for cooking fuel also gives a significant positive impact on the perceived health of people who use it.

Second, by stratifying the whole population into different sub-groups, we can see a more nuanced explanation for the determinants of health perception. Thus, suggestions for policy and/or further research are specified as follows: (1) studies on the inter-relationships between health and gender, age, income, education, lifestyle, and place of residences have been relatively under-studied and should be highly encouraged; (2) improving the economic condition with regards to working environment and job availability, as well as reducing social stigma and strengthening social support structure for women, especially for single females; (3) creating safe and physically active outdoor space for the elderly, especially featuring the use of green space and parks, while bettering the indoors environment for young adults; (4) more research needs to be done regarding the *hukou* status and perceived health, especially attracting the population to specific types of neighborhoods, to have better policies that can increase rural migrants' quality of life.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su142013389/s1, Figure S1: A typical traditional housing neighborhood; Table S1: Statistical summary of variables by the whole population, gender, and age group; Table S2: . Statistical summary of all variables by neighborhood type; Table S3: Linear regression results of self-rated health perception of the whole population and by gender; Table S4: Linear regression results of self-rated health perception by age group; Table S5. Odd ratio and confidence interval of self-rated health perception by age group. Table S6: Linear regression results of self-rated health perception by neighborhood type; Table S7. Odd ratio and confidence interval of self-rated health perception by neighborhood type. List S1: Questions used in the survey and given possible answers for multiple choice questions.

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