

## Research Article

# Physical Activity among Rural Residents in Eastern, Central, and Western Provinces of China: A Cross-Sectional Survey

Cheng-Yao Liang <sup>1</sup>, Zhi-Yuan Zheng,<sup>1</sup> Yu-Gao Wu,<sup>1</sup> Zhuo-Yang Li,<sup>1</sup> Ping Wang,<sup>2</sup> Yi-Yang Wang,<sup>3</sup> Bai-Xue Lin,<sup>1</sup> and Jing Fang <sup>1</sup>

<sup>1</sup>Institute for Health Sciences, Kunming Medical University, Kunming 650500, China

<sup>2</sup>Quality Control Office of Weifang People's Hospital, Weifang 261000, China

<sup>3</sup>Medical Department of Heze Municipal Hospital, Heze 274000, China

Correspondence should be addressed to Jing Fang; [fangjing07@126.com](mailto:fangjing07@126.com)

Received 21 November 2022; Revised 14 January 2023; Accepted 16 January 2023; Published 23 January 2023

Academic Editor: Georgian Badicu

Copyright © 2023 Cheng-Yao Liang et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Physical activity (PA) in which physical exercise (PE) is an important component is probably the most important intervention for preventing noncommunicable diseases (NCDs). However, few studies on PA and PE of rural residents in China were reported. This study conducted the first population-based cross-sectional survey in three provinces of China in 2021 that examined both PA and PE as well as the associated factors of rural residents. The International Physical Activity Questionnaire Short Form (IPAQ-S) was used, and a total of 3780 rural residents were surveyed. The result showed that 22.2% of the rural residents were physical inactivity and rural residents reporting practice of PE was 54.4%. Binary logistic regression analyses showed that being female, people aged between 15 to 34 years or 60 years old and above, employees of governmental departments/retirees, school students, the unemployed, and people with NCDs were risk factors of PA while ethnic minority groups, smoking, and alcohol consumption were risk factors of PE. Health promotion programme aiming at increasing people's PA in rural China is urgently needed, and it should focus on the population groups of the female, people aged 60 years and above, school students, the unemployed, and people with NCDs.

## 1. Background

Physical activity (PA) is undoubtedly very important as it has a variety of beneficial effects on physical, mental, and spiritual health and wellness. The World Health Organization (WHO) defines PA as “any bodily movement produced by skeletal muscles which results in energy expenditure above resting level” [1, 2]. The evidence about the health benefits of regular PA is well established [3]. Benefits of PA have been reported for numerous outcomes such as mortality decline [4, 5], cognitive and physical improvement [5–7], glycaemic control [8, 9], relief of pain and disability [10–12], muscle and bone strength [13], reducing depressive symptoms [14], and improving functional mobility and well-being [15, 16]. Physical exercise (PE) is an important source of PA. The benefits of PE to human body include but not limited to immunological [17], musculoskeletal [18], respi-

ratory [19], and hormonal aspects [20]. Specifically for the cardiovascular system, PE increases fatty acid oxidation, cardiac output, vascular smooth muscle relaxation, endothelial nitric oxide synthase expression, and nitric oxide availability and improves plasma lipid profiles [16] while at the same time reducing resting heart rate and blood pressure, aortic valve calcification, and vascular resistance [21].

Noncommunicable diseases (NCDs), also known as chronic conditions or chronic diseases, are long lasting diseases. The main types of NCDs include cardiovascular diseases, cancers, musculoskeletal diseases, chronic respiratory diseases, mental illness, and diabetes. The ever-growing prevalence of NCDs has become a global health concern [22]. According to a report published by the World Health Organization (WHO) in 2019, the top 10 causes of death accounted for 55% of the 55.4 million deaths worldwide and 7 of the 10 leading causes of deaths were NCDs [23].

In China, there was 9.05 million NCDs deaths in 2019 [24], and about 82% of China's disease burden is due to the prevalence of NCDs [25]. Global Health Observatory Data issued by the WHO has listed risk factors for NCDs including physical inactivity, alcohol intake, tobacco use, hypertension, obesity, raised cholesterol, unhealthy diet, and raised blood glucose [26]. Of these factors, physical inactivity is considered as the fourth leading risk factor for global mortality [27]. In 2015, physical inactivity directly contributed to 21% of breast cancers, 25% of colon cancers, 27% of diabetes, and 30% of ischemic heart diseases globally [28]. Recent estimates indicate that 9% of the overall global premature mortality,  $\approx$ 5.3 million deaths, is directly attributable to physical inactivity, a figure comparable to the global smoking-related mortality (5.1 million) [29]. Conservatively estimated, physical inactivity cost health-care systems \$53.8 billion worldwide in 2013, of which \$31.2 billion was paid by the public sector, \$12.9 billion by the private sector, and \$9.7 billion by households. In addition, physical inactivity-related deaths contribute to \$13.7 billion in productivity losses, and physical inactivity was responsible for 13.4 million disability-adjusted life years (DALYs) worldwide [30].

Despite the well-acknowledged benefits linked to PA, a significant proportion of the global population remains physically inactive. Globally, in 2016 among the 1.9 million individuals providing self-reported PA levels via the International Physical Activity Questionnaire (IPAQ), the global prevalence rate of physical inactivity was 27.5%, which was slightly smaller than 28.5%, the prevalence rate of physical inactivity in the globe in 2001 [31], showing no progress has been made in PA of global population during a period of 15 years. However, the prevalence rates of physical inactivity vary across the groups of low-income, middle-income, and high-income countries, with 15.5%, 27.5%, and 31.1% of adult populations reporting physical inactivity, respectively [32]. Furthermore, in a few high-income countries, low levels of adult participation in PA are much more concerning [3]. A study reported that globally, older adults (aged 60 years and above) are the least active population group: the prevalence rate of physical inactivity of this group was 55%, and only 45% of them met the WHO recommendation for 150 weekly minutes of moderate-to-vigorous physical activity for achieving health benefits [33].

Reducing physical inactivity is a challenge for many nations. As a rising developing country with a big population, China faces the challenge of climbing NCDs in which physical inactivity may be a significant contributor. One national survey reported that Chinese citizens aged 7 years and above practicing regular PE merely 37.2% in 2020 [34] while another survey of urban residents conducted in Liaoning Province of China in 2018 reported that the prevalence rate of physical inactivity was 25.3% [35]. Although the two studies focused on different issues (PE versus PA), both studies indicate the possible lower level of PA among Chinese. Until now, there has no nationwide survey on people's PA in China been reported although several studies on PA in certain areas of China could be found and majority of those studies focused on urban dwellers of economically

more developed regions [36–38]. What is the PA status of rural residents in China? What percentage of rural residents is physically inactive? What percentage of rural residents practices regular PE? What are the associated factors? It is very imperative and important to explore answers to these questions in order to better prevent and control NCDs in rural China. Therefore, this study used the International Physical Activity Questionnaire Short Form (IPAQ-S) [39] to conduct a questionnaire survey in rural areas of Shandong, Shanxi, and Yunnan provinces representing eastern, central, and western region of China in order to understand the current status of PA and its influencing factors as well as frequency and pattern of PE among rural residents in China. The findings of this study will reflect the overall status of PA, PE, and physical inactivity of the rural residents in China, which will fill out the current research gap and more important be helpful for the design of interventions to reduce physical inactivity among Chinese rural residents.

## 2. Methods

*2.1. Study Design.* We planned and conducted a population-based cross-sectional survey and used a multistage random sampling method. We first selected one province, respectively, from the eastern, central, and western regions of China and secondly selected two counties from each of the three selected provinces, which produced a sample of six counties located in three provinces. Finally, Changle County of Weifang City and Shan County of Heze City in Shandong Province, Zhongyang County and Lan County of Lvliang City in Shanxi Province, Yao'an County of Chuxiong Yi Autonomous Prefecture, and Zhen Yuan Yi Hani Lahu Autonomous County of Pu'er City in Yunnan Province were selected as sampling counties for the study. The multistage random sampling method was employed in each sampled county to get the sample of rural residents: three townships were randomly selected in each county where rural residents aged above 15 years old living there for more than 6 months were randomly selected to participate in the survey. Figure 1 illustrates the sampling process from province to survey participants at township level. All participants were informed the purpose and content of this survey, and informed consent was obtained from each participant. The survey was conducted in a face-to-face manner, and the investigators were postgraduate students and teachers from the School of Public Health at Kunming Medical University who had been well trained prior to the survey. The survey was approved by the Research Ethic Review Committee of Kunming Medical University.

For the assessment of self-reported PA, the IPAQ was employed by many studies. IPAQ is an instrument designed to assess levels of PA, and short and long forms of the questionnaire have been developed on the basis of self-report population surveys [40], and the instrument has been validated in different languages [41–43]. In the present study, the IPAQ-S was used. This questionnaire comprises of seven questions that assess the frequency and duration of vigorously intense physical activity (VPA), moderately intense physical activity (MPA), and walking for at least 10 min

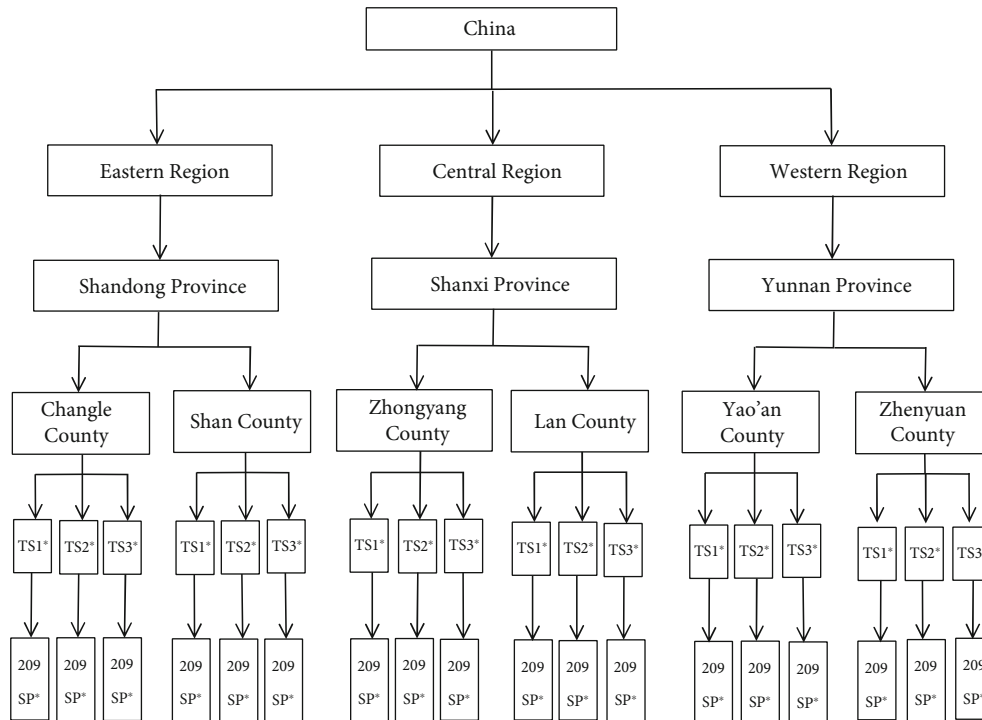


FIGURE 1: The sampling process from province to survey participants. \*TS: township; SP: survey participants.

during the past week. The IPAQ-S assesses total weekly PA, whereas the intensity of activity is converted to metabolic equivalent of task (MET) units, as recommended by previous study [44]. Guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ) describe recommended methods of scoring the data derived from the IPAQ-S. According to the guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ), the selected MET values were derived from work undertaken during the IPAQ reliability study. MET score was derived for each type of activity. For example, all types of walking were included, and MET value for walking was created. The same procedure was undertaken for MPA and VPA. The following values continue to be used for the analysis of IPAQ data: walking = 3.3 METs, MPA = 4.0 METs, and VPA = 8.0 METs. Using these values, four continuous scores are defined: (1) walking MET  $\times$  min/wk = 3.3  $\times$  walking minutes/day  $\times$  walking days/week; (2) MPA MET  $\times$  min/wk = 4.0  $\times$  MPA minutes/day  $\times$  moderate-intensity days/week; (3) VPA MET  $\times$  min/wk = 8.0  $\times$  VPA minutes/day  $\times$  vigorous-intensity days/week; and (4) total PA MET  $\times$  min/wk = sum of (walking + MPA + VPA MET)  $\times$  minutes/week scores [40]. In this study, the English version of the IPAQ-S was translated into Chinese and adapted to the local situation in rural China to form the PA questionnaire for Chinese rural residents. The questionnaire also includes questions about the pattern, length, and frequency of PE among rural residents.

**2.2. Sample Size of Rural Residents.** In order to estimate the sample size of rural residents, we used the equation:

$n = ((\mu_{(1-\alpha/2)}^2 \times p(1-p))/\delta^2) \times deff$ , in which  $p = 37.2\%$  that was the proportion of people aged 7 years and above who practiced PE regularly reported by a national survey conducted in China in 2020 [34],  $\delta = p \times 20\% = 0.0744$ ,  $\alpha = 0.05$ ,  $\mu(1-\alpha/2) = 1.96$ , and design efficiency  $deff = 1.5$ ; then, the estimated sample size  $n$  was 199 survey participants per township. Considering the possible invalid questionnaires, we expanded the actual sample size by 5%, and finally, we obtained the sample size of 209 survey participants in each township and 627 survey participants in each county.

**2.3. Variables and Outcomes Measurements.** Data on gender, ethnicity, age, marital status, educational attainment, occupation, annual per capital household income, status of NCDs, and lifestyle factors, such as smoking and alcohol consumption, were collected. Ethnicity was categorised into two groups: the Han group and ethnic minority group. Age was categorised into three groups: 15-34 years (young group), 35-59 years (middle-aged adults), and 60 years and above (old adults). Marital status was categorised into four groups: single, married, widowed, and divorced. Educational attainment was divided into five groups following the school system in China: illiterate or have little literacy, primary school, junior high school, high school, and undergraduate and above. Occupation was divided into five groups: farmers/migrant workers, business men/service workers, employees of governmental departments/retirees, school students, and unemployed. Annual per capital household income was divided into 4 groups: less than 5000 Chinese yuan (CNY), equal to or greater than 5000 but less than

10000 CNY, equal to or greater than 10000 but less than 20000 CNY, and 20000 CNY and above. Criteria for NCDs are as follows: reported by survey participants that was supported with diagnosis from hospitals at county and above level. MET is the common unit used internationally to reflect the absolute intensity of PA [45]. A MET is defined as the amount of consumed oxygen at rest by a person, which is approximately 3.5 ml O<sub>2</sub>/kg/min. Calculation of total PA was done according to the guidelines for data processing and analysis of the IPAQ-S [40]: a MET value of 3.3 was assigned for walking, a MET value of 4.0 was assigned for moderately intense physical activity (MPA), and a MET value of 8.0 was assigned for vigorously intense physical activity (VPA). Four equations [40, 46] of PA in the guidelines for data processing and analysis of the IPAQ-S were defined: (1) walking MET × min/wk = 3.3 × walking minutes/day × walking days/week; (2) MPA MET × min/wk = 4.0 × MPA minutes/day × moderate – intensity days/week; (3) VPA MET × min/wk = 8.0 × VPA minutes/day × vigorous – intensity days/week; and (4) total PA MET × min/wk = sum of (walking + MPA + VPA MET) × minutes/week scores. According to the WHO guidelines [47], physical inactivity was defined as not meeting any of the following three criteria: (1) 30 min of moderate-intensity PA on at least 5 days every week; (2) 20 min of vigorous-intensity PA on at least 3 days every week; and (3) an equivalent combination achieving 600 MET per week.

**2.4. Statistical Analysis.** The descriptive data of the survey participants was expressed as frequencies and percentages. The chi-squared test was used to compare frequencies and percentages between groups. Lastly, binary logistic regression was used to explore the influencing factors of PA and PE. The main outcomes of interest were the dichotomous dependent variables of PA (1 = physically inactive and 0 = physically active) and PE (1 = no and 0 = yes). The following variables were included into the binary logistic regression model: (1) gender, (2) ethnicity, (3) age, (4) marital status, (5) educational attainment, (6) occupation, (7) annual per capital household income, (8) smoking, (9) alcohol consumption, and (10) status of NCDs. All statistical analyses were performed using IBM SPSS for Statistics (version 24; SPSS Inc. (version 24.0 Armonk, NY, USA)). For all statistical analyses,  $p \leq 0.05$  was considered statistically significant.

### 3. Results

**3.1. Demographic Characteristics of Survey Participants.** A total of 3780 rural residents (response rate 98.6%) participated in the survey. Their median (IQR) age was 53 (P25: 39 and P75:65) years with 46.9% aged between 35 and 59 years and 35.0% aged 60 years and above. Of the total survey participants, 49.4% were male and 50.6% were female. The Han ethnic group accounted for 90.1%. Regarding educational status, 49.8% were below secondary school and very few (1.5%) had undergraduate and above level. Majority of the survey participants (86.5%) were married. In terms of occupation, 56.3% were farmers/migrant workers and

24.6% were the unemployed. The median (IQR) annual per capita household income was 9000.00 (P25:3333.33 and P75:17142.85) CNY. Besides, there were 1340 (35.4%) survey participants with NCDs in this study. Details about demographic characteristics of the survey participants are shown in Table 1.

**3.2. PA of Survey Participants.** The result showed that although 77.8% of the all survey participants were physically active, 22.2% were physical inactivity, of which the female had higher prevalence rate of physical inactivity (25.2%) than their male counterparts (19.1%) ( $\chi^2 = 20.520$ ,  $p < 0.001$ ). The prevalence rate of physical inactivity of the Han ethnic group (23.3%) was higher than that of ethnic minority groups (12.3%) ( $\chi^2 = 23.418$ ,  $p < 0.001$ ). In terms of occupation, the prevalence rate of physical inactivity was highest among the unemployed, at 37.4%, and that prevalence rate of physical inactivity of employees of governmental departments/retirees was 24.5% ( $\chi^2 = 187.695$ ,  $p < 0.001$ ). Among age groups, old adults (aged 60 years and above) were the most inactive group of the population (27.8%) ( $\chi^2 = 51.415$ ,  $p < 0.001$ ), compared to young group and middle-aged adults. The prevalence rate of physical inactivity of the survey participants with NCDs was 27.8%, higher than that of survey participants without NCDs (19.1%) ( $\chi^2 = 37.848$ ,  $p < 0.001$ ). The different prevalence rates of physical inactivity among different annual per capita household income groups, smoking groups, and alcohol consumption groups were also statistically significant by chi-squared test. Details about PA of the survey participants by demographic variables are shown in Table 2.

**3.3. Influencing Factors of PA of Survey Participants.** We entered the variables presented in Table 2 that were statistically significant by chi-squared test into the model of binary logistic regression analysis, and the results showed that gender, ethnicity, age, occupation, and status of NCDs were the influencing factors of PA. As shown in Table 3, ethnic minority groups (OR = 0.559, 95% CI, 0.401-0.778) was protective factor of PA while female (OR = 1.307, 95% CI, 1.107-1.543), people aged between 15 and 34 years (OR = 1.426, 95% CI, 1.119-1.818) or 60 years and above (OR = 1.351, 95% CI, 1.113-1.641), employees of governmental departments/retirees (OR = 1.603, 95% CI, 1.127-2.282), school students (OR = 2.141, 95% CI, 1.255-3.650), the unemployed (OR = 2.461, 95% CI, 2.051-2.954), and people with NCDs (OR = 1.430, 95% CI, 1.188-1.721) were risk factors of PA.

**3.4. PE of Survey Participants.** In this survey, the proportion of rural residents who reporting practice of PE was 54.4%. Among those reporting practice of PE, 1582 survey participants (76.8%) practiced PE five times and above per week and 479 survey participants (23.2%) practiced PE less than five times per week. About 93.8% of survey participants practiced PE for 30 minutes and above each time while the rest 6.2% practiced PE for less than 30 minutes. The most frequently performed PE was walking/brisk walking (1614 participants, 78.3%). There were 389 (18.9%), 336 (16.3%), 104 (5.0%),

TABLE 1: Demographic characteristics of survey participants ( $n = 3780$ ).

Variables		<i>n</i>	%
Gender	Male	1867	49.4
	Female	1913	50.6
Ethnicity	Han ethnic group	3407	90.1
	Ethnic minority groups	373	9.9
Age (years)	15-34	685	18.1
	35-59	1773	46.9
	60 and above	1322	35.0
Marital status	Single	201	5.3
	Married	3271	86.5
	Widowed	283	7.5
	Divorced	25	0.7
Educational attainment	Illiterate or have little literacy	1006	26.5
	Primary school	879	23.3
	Junior high school	1318	34.9
	High school	521	13.8
	Undergraduate and above	56	1.5
Occupation	Farmers/migrant workers	2127	56.3
	Business men/service workers	452	12.0
	Employees of governmental departments/retirees	192	5.1
	School students	77	2.0
	The unemployed	932	24.6
Annual per capita household income (CNY)	0 ~	1414	37.4
	5000 ~	835	22.1
	10000 ~	862	22.8
	20000 ~	669	17.7
Status of NCDs	Yes	1340	35.4
	No	2440	64.6

and 65 (3.2%) of the survey participants reporting practice of running, dancing/calisthenics, mountain climbing, and badminton/table tennis, respectively, while fitness and t'ai chi ch'uan were the least reported PE practiced only by 20 (1.0%) and 11 (0.6%) participants, respectively. Details about PE of the survey participants are shown in Table 4.

**3.5. Influencing Factors of PE of Survey Residents.** We entered the same variables presented in Table 2 that were statistically significant by chi-squared test into the model of binary logistic regression analysis of PE, and the results showed that ethnicity, age, occupation, educational attainment, smoking, and alcohol consumption were the influencing factors of PE. As shown in Table 5, people aged between 35 and 59 years (OR = 0.590, 95% CI, 0.478-0.728) or 60 years and above (OR = 0.416, 95% CI, 0.329-0.528), employees of governmental departments/retiree (OR = 0.359, 95% CI, 0.249-0.519), school students (OR = 0.086, 95% CI, 0.038-0.195), the unemployed (OR = 0.490, 95% CI, 0.414-0.580), and people with education level of high school (OR = 0.603, 95% CI, 0.464-0.784) or undergraduate and above (OR = 0.346, 95% CI,

0.162-0.739) were protective factors of PE while ethnic minority groups (OR = 1.525, 95% CI, 1.210-1.921), smoking (OR = 1.173, 95% CI, 1.000-1.375), and alcohol consumption (OR = 1.371, 95% CI, 1.151-1.633) were risk factors of PE.

## 4. Discussion

**4.1. Status of PA among Rural Residents of China.** PA is probably the single most important intervention for preventing NCDs, making it one of the primary determinants of health [48]. The WHO recommends at least 150 min of MPA per week, i.e., 30 min a day, 5 days a week, for all adults [49]. Our survey showed that 22.2% of the rural residents in three provinces of China were physical inactivity, which was slightly smaller than the level of physical inactivity in Liaoning Province of China in 2018, reported as 25.3% [35]. This indicates that nearly a quarter of rural residents in three provinces of China failed to meet the recommended PA level to achieve health benefits, leading to negative effects on the general health and rising NCDs risk of rural residents in China.

TABLE 2: PA status of survey participants ( $n = 3780$ ).

Variables	Physically active		Physically inactive		Chi-squared value	p value	
	n	%	n	%			
Total	2940	77.8	840	22.2			
Gender	Male	1510	80.9	357	19.1	20.520	<0.001
	Female	1430	74.8	483	25.2		
Ethnicity	Han ethnic group	2613	76.7	794	23.3	23.418	<0.001
	Ethnic minority groups	327	87.7	46	12.3		
Age (years)	15-34	517	75.5	168	24.5	51.415	<0.001
	35-59	1468	82.8	305	17.2		
	60 and above	955	72.2	367	27.8		
Marital status	Single	145	72.1	56	27.9	22.952	<0.001
	Married	2582	78.9	689	21.1		
	Widowed	192	67.8	91	32.2		
	Divorced	21	84.0	4	16.0		
Educational attainment	Illiterate or have little literacy	744	74.0	262	26.0	12.028	0.017
	Primary school	701	79.7	178	20.3		
	Junior high school	1039	78.8	279	21.2		
	High school	413	79.3	108	20.7		
	Undergraduate and above	43	76.8	13	23.2		
	Farmers/migrant workers	1765	83.0	362	17.0		
Occupation	Business men/service workers	395	87.4	57	12.6	187.695	<0.001
	Employees of governmental departments/retirees	145	75.5	47	24.5		
	School students	52	67.5	25	32.5		
	The unemployed	583	62.6	349	37.4		
	Annual per capita household income (CNY)	0 ~ 5000 ~ 10000 ~ 20000 ~	1045	73.9	369		
	670	80.2	165	19.8			
	678	78.7	184	21.3			
Smoking	Yes	547	81.8	122	18.2	6.764	0.009
	No	958	80.4	234	19.6		
		1982	76.6	606	23.4		

TABLE 2: Continued.

Variables	Physically active		Physically inactive		Chi-squared value	p value
	n	%	n	%		
Alcohol consumption	720	83.5	142	16.5	21.352	<0.001
	2220	76.1	698	23.9		
Status of NCDs	967	72.2	373	27.8	37.848	<0.001
	1973	80.9	467	19.1		

TABLE 3: The results of binary logistic regression analysis for influencing factors of PA of survey participants.

Variables		$\beta$	S.E.	<i>p</i> value	OR (95% CI)
Gender	Male				Ref
	Female	0.268	0.085	0.002	1.307 (1.107-1.543)
Ethnicity	Han ethnic group				Ref
	Ethnic minority groups	-0.582	0.169	0.001	0.559 (0.401-0.778)
Age (years)	35-59				Ref
	15-34	0.355	0.124	0.004	1.426 (1.119-1.818)
	60 and above	0.301	0.099	0.002	1.351 (1.113-1.641)
Occupation	Farmers/migrant workers				Ref
	Business men/service workers	-0.301	0.158	0.057	0.740 (0.544-1.009)
	Employees of governmental departments/retirees	0.472	0.180	0.009	1.603 (1.127-2.282)
	School students	0.761	0.272	0.005	2.141 (1.255-3.650)
	The unemployed	0.901	0.093	<0.001	2.461 (2.051-2.954)
Status of NCDs	No				Ref
	Yes	0.358	0.094	<0.001	1.430 (1.188-1.721)

TABLE 4: Frequency, duration, and pattern of PE of survey participants.

Ways of physical exercise	%	Frequency of exercise per week	%	Duration of each time	%
Walking/brisk walking	78.3	Less than 5 times	23.2	<30 min	6.2
Running	18.9				
Dancing/calisthenics	16.3	5 times	5.6	30-60 min	73.5
Mountain climbing	5.0				
Badminton/table tennis	3.2	More than 5 times	71.2	>60 min	20.3
Skipping rope/shuttlecock	2.9				
Basketball/football/volleyball	1.9				
Bicycle	1.6				
Fitness	1.0				
T'ai chi ch'uan	0.6				

**4.2. Gender Is an Influencing Factor of PA.** This study examined a number of factors such as gender, ethnicity, age, occupation, and status of NCDs that may have impact on the PA of rural residents in China. Among others, gender had significant impact on PA. Our survey found that female rural residents were less physically active than their male counterparts. The prevalence rate of physical inactivity of the female was 25.2%, higher than the male (19.1%). Previous studies reported similar findings [50–52]. This might be caused by traditional customs and gender roles. In most rural households, women are typically assumed the role of cooking, cleaning, and caring for children and the elderly in the family [51]; those tasks are typically less physically intensive and thus may not be well captured by the IPAQ-S. Compared with women, men usually more engage in heavier agricultural activities, related to crop growing and harvest such as carrying chemical fertilizers to field.

**4.3. Age Is an Influencing Factor of PA.** Our results showed that age had significant impact on PA. Among the survey participants, the prevalence rate of physical inactivity of

old adults (aged 60 years and above) was the highest (27.8%) while only 17.2% of middle-aged adults (aged 35-59 years) were physical inactivity. Many studies reported age-related decline in PA [50, 53, 54]. Because of ageing, old adults tend to face more constraints on participation in PA than their younger peers [55]. The biological process of aging is likely to be the reason for this outcome. Old adults tend to face a more serious deterioration in health and thus have greater difficulties in performing PA. They are more likely to perform less intensity PA, which contribute to low level of PA of old adults.

**4.4. Occupation Is an Influencing Factor of PA.** In the present survey, occupation had impact on PA. The finding was similar with previous studies [56–58]. We found out that the unemployed and school students had lower level of PA. One plausible explanation could be that the unemployed have fewer work commitments and often live a laid-back lifestyle and consequently would be less physically active. As for the student group, they face strong cultural and social pressure to achieve academic excellence and thus have little



TABLE 5: The results of binary logistic regression for influencing factors of PE of survey participants.

Variables		$\beta$	S.E.	<i>p</i> value	OR (95% CI)
Ethnicity	Han ethnic group				Ref
	Ethnic minority groups	0.422	0.118	<0.001	1.525 (1.210-1.921)
Age (years)	15-34				Ref
	35-59	-0.527	0.107	<0.001	0.590 (0.478-0.728)
	60 and above	-0.876	0.121	<0.001	0.416 (0.329-0.528)
Occupation	Farmers/migrant workers				Ref
	Business men/service workers	-0.020	0.110	0.852	0.980 (0.790-1.216)
	Employees of governmental departments/retirees	-1.024	0.188	<0.001	0.359 (0.249-0.519)
	School students	-2.449	0.414	<0.001	0.086 (0.038-0.195)
	The unemployed	-0.713	0.086	<0.001	0.490 (0.414-0.580)
Educational attainment	Illiterate or have little literacy				Ref
	Primary school	0.066	0.099	0.508	1.068 (0.879-1.296)
	Junior high school	-0.228	0.096	0.018	0.796 (0.659-0.961)
	High school	-0.506	0.134	<0.001	0.603 (0.464-0.784)
	Undergraduate and above	-1.061	0.387	0.006	0.346 (0.162-0.739)
Smoking	No				Ref
	Yes	0.159	0.081	0.050	1.173 (1.000-1.375)
Alcohol consumption	No				Ref
	Yes	0.316	0.089	<0.001	1.371 (1.151-1.633)

time to spend on physical activities. This result is in line with previous study that consistently showed disappointingly low levels of PA among Chinese students [59], and being physically underactive can increase the likelihood of developing unhealthy of school students in China.

**4.5. NCDs Have Impact on the PA of Rural Residents.** The results of the present survey showed that the prevalence rate of physical inactivity of rural residents with NCDs was 27.8%, higher than those without NCDs (19.1%). Similar findings were reported by previous studies. NCDs, such as cardiovascular and neurological diseases, were events that are strongly associated with physical inactivity, which produced catabolic effects on the muscles and nervous and cardiovascular systems, which in conjunction favor the physical performance decline [60–63]. Besides, decreased mobility from joint diseases was a limiting factor for adherence to PA in rural residents with NCDs [64]. The likelihood of being insufficiently active was higher in those having NCDs [63, 65].

**4.6. Ethnicity Is an Influencing Factor of PA.** We found that ethnicity had a significant effect on PA in China. The prevalence rate of physical inactivity of Han ethnic group (23.3%) was significantly higher than the one of ethnic minority groups (12.3%). One plausible reason was that the majority of surveyed Han ethnic group live in the more economically developed eastern and central regions of China where most agricultural activities are undertaken with machine while most of surveyed ethnic minority groups reside in the less developed western region of China where

most agricultural activities are still manually conducted. The level of individuals' income of Han ethnic group was higher than that of ethnic minority groups. Previous studies [66–68] showed that the higher the level of individuals' income, the less likely that individuals being physically active. Most of higher income individuals are usually engaged with jobs that are at low-intensity PA that cause lower level of PA.

**4.7. PE of Rural Residents and Associated Factors.** PE is an important source of PA [69]. We found 54.4% of survey participants reporting practice of PE at least once a week, and the most commonly performed PE was walking/brisk walking (78.3%). We also found that unhealthy lifestyle habits, such as smoking and alcohol consumption, were risk factors of PE. According to General Administration of Sport of China, in 2020, 63.1% of rural residents in China practiced PE at least once a week and walking/brisk walking (22.7%) and running (19.8%) were the top two commonly practiced PE by adults in China that was followed by badminton (8.9%), cycling (7.3%), and basketball (5.4%) [70]. The proportion of rural residents practicing PE in our survey is smaller than 63.1%. Interestingly, the logistic regression analysis result showed that those groups who were less physically active such as the unemployed, employees of governmental departments/retirees, students, and the elderly are more likely to undertake PE, which may be a way to compensate their physical inactivity and also a potential entry point for intervention. However, the current ways of PE adopted by rural residents were simple with little requirements for equipment and space that may be determined by

the less developed sports and PE facilities in rural areas. Due to the lack of sports and recreational infrastructure and inadequate built environments that can facilitate badminton/cycling/basketball and other forms of PE in rural areas of China, rural residents have little choice but can only adopt simple forms of physical exercise such as walking and running and their enthusiasm for PE can be reduced. With further economic development and people shifting away from organically incorporating PA in daily work activities, people would need to pursue PA more proactively through PE [71]. Government should pay more attention to build sport and PE facilities in rural areas that will improve PE level of rural residents.

## 5. Limitations

There are some limitations in this study; therefore, our findings should be interpreted with certain caution. First, this study is limited by its cross-sectional design, and thus, it precludes any conclusions on causality. Second, this study estimated the volume of PA using IPAQ-S that requires survey participants to self-report and recall their PA of the last week, which can produce recall bias, and because the survey was conducted in a face-to-face manner, the bias caused by social desirability could also be produced. Third, although the use of a validated instrument to evaluate PA may be regarded as a strength of this study, some studies have indicated that the IPAQ could overestimate the total PA, when compared with data measured by an objective method [72, 73]. Future studies are needed that should validate our findings by utilizing longitudinal data with repeated measurement of PA preferably based on objective measurements.

## 6. Conclusions

We conducted a survey to examine both PA and PE status as well as the associated factors of rural residents in China. Around a quarter of rural residents (22.2%) were physical inactivity, and the rural residents reporting practice of PE were only 54.4%. The survey revealed that gender, ethnicity, age, occupation, and status of NCDs were the influencing factors of PA of rural residents in China while ethnicity, age, occupation, educational attainment, smoking, and alcohol consumption were the influencing factors of PE of those populations. The results of this survey provide useful information to inform the design and development of policies and interventions for the promotion of PA among rural residents in China. Health promotion programme aiming at increasing people's PA in rural China should focus on the populations of the female, people at age 60 years and above, school students, the unemployed, and people with NCDs.

## Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

## Ethical Approval

The study was approved by the Research Ethic Review Committee of Kunming Medical University with the document number KMMU2022MEC084.

## Consent

All participants were fully informed about the nature, goal, procedures, and risks of the study and gave their informed consent.

## Disclosure

A preprint has previously been published [74].

## Conflicts of Interest

The authors declare that they have no competing interests.

## Authors' Contributions

Conceptualization was carried out by JF. Methodology and statistics were carried out by ZYZ, YGW, ZYL, YYW, PW, and BXL. Writing of the original draft was carried out by CYL. Writing, editing, and reviewing of the manuscript were carried out by JF. Investigation was carried out by JF, CYL, ZYZ, YGW, ZYL, YYW, PW, and BXL. All authors read and approved the final manuscript.

## Acknowledgments

This study was supported by the National Social Science Fund of China (No. 19XGL022). The research team would like to thank the research assistants and students from Kunming Medical University for their role in data collections as well as the survey participants from the three provinces for their voluntary participation in the survey.

## References

- [1] T. Lebacqz, C. Ost, S. Bel et al., "Physical activity and sedentary behavior in Belgium (BNFCS2014): design, methods and expected outcomes," *Archives of Public Health*, vol. 74, no. 1, p. 44, 2016.
- [2] M. Saridi, T. Filippopoulou, G. Tzitzikos, P. Sarafis, K. Souliotis, and D. Karakatsani, "Correlating physical activity and quality of life of healthcare workers," *BMC Research Notes*, vol. 12, no. 1, p. 208, 2019.
- [3] K. L. Piercy, R. P. Troiano, R. M. Ballard et al., "The physical activity guidelines for Americans," *Journal of the American Medical Association*, vol. 320, no. 19, pp. 2020–2028, 2018.
- [4] B. Abell, P. Glasziou, and T. Hoffmann, "The contribution of individual exercise training components to clinical outcomes in randomised controlled trials of cardiac rehabilitation: a systematic review and meta-regression," *Sports Medicine-Open*, vol. 3, no. 1, p. 19, 2017.
- [5] D. Anderson, C. Seib, and L. J. M. Rasmussen, "Can physical activity prevent physical and cognitive decline in postmenopausal women?: a systematic review of the literature," *Maturitas*, vol. 79, no. 1, pp. 14–33, 2014.

- [6] M. Barbaric, E. Brooks, L. Moore, and O. Cheifetz, "Effects of physical activity on cancer survival: a systematic review," *Physiotherapy Canada*, vol. 62, no. 1, pp. 25–34, 2010.
- [7] P. A. Barlow, P. Otahal, M. G. Schultz, C. M. Shing, and J. E. Sharman, "Low exercise blood pressure and risk of cardiovascular events and all-cause mortality: systematic review and meta-analysis," *Atherosclerosis*, vol. 237, no. 1, pp. 13–22, 2014.
- [8] Y. M. Aljawarneh, D. W. Wardell, G. L. Wood, and C. L. Rozmus, "A systematic review of physical activity and exercise on physiological and biochemical outcomes in children and adolescents with type 1 diabetes," *Journal of Nursing Scholarship*, vol. 51, no. 3, pp. 337–345, 2019.
- [9] S. F. M. Chastin, M. De Craemer, K. De Cocker et al., "How does light-intensity physical activity associate with adult cardiometabolic health and mortality? Systematic review with meta-analysis of experimental and observational studies," *British Journal of Sports Medicine*, vol. 53, no. 6, pp. 370–376, 2019.
- [10] L. J. Geneen, R. A. Moore, C. Clarke, D. Martin, L. A. Colvin, and B. H. Smith, "Physical activity and exercise for chronic pain in adults: an overview of Cochrane Reviews," *Cochrane Database of Systematic Reviews*, vol. 4, p. CD011279, 2017.
- [11] S. Y. Abdulla, D. Southerst, P. Côté et al., "Is exercise effective for the management of subacromial impingement syndrome and other soft tissue injuries of the shoulder? A systematic review by the Ontario protocol for traffic injury management (OPTIMa) collaboration," *Manual Therapy*, vol. 20, no. 5, pp. 646–656, 2015.
- [12] M. H. Alanazi, E. C. Parent, and E. Dennett, "Effect of stabilization exercise on back pain, disability and quality of life in adults with scoliosis: a systematic review," *European Journal of Physical and Rehabilitation Medicine*, vol. 54, no. 5, pp. 647–653, 2018.
- [13] J. A. Adsett, A. M. Mudge, N. Morris, S. Kuys, and J. D. Paratz, "Aquatic exercise training and stable heart failure: a systematic review and meta-analysis," *International Journal of Cardiology*, vol. 186, pp. 22–28, 2015.
- [14] B. C. Adamson, I. Ensari, and R. W. Motl, "Effect of exercise on depressive symptoms in adults with neurologic disorders: a systematic review and meta-analysis," *Archives of Physical Medicine and Rehabilitation*, vol. 96, no. 7, pp. 1329–1338, 2015.
- [15] S. Abidin, R. K. Welch, J. Byron-Daniel, and J. Meyrick, "The effectiveness of physical activity interventions in improving well-being across office-based workplace settings: a systematic review," *Public Health*, vol. 160, pp. 70–76, 2018.
- [16] H. Albalawi, E. Coulter, N. Ghouri, and L. Paul, "The effectiveness of structured exercise in the south Asian population with type 2 diabetes: a systematic review," *The Physician and Sports Medicine*, vol. 45, no. 4, pp. 408–417, 2017.
- [17] M. Sellami, M. Gasmı, J. Denham et al., "Effects of acute and chronic exercise on immunological parameters in the elderly aged: can physical activity counteract the effects of aging?," *Frontiers in Immunology*, vol. 9, p. 2187, 2018.
- [18] K. B. Hagen, H. Dagfinrud, R. H. Moe et al., "Exercise therapy for bone and muscle health: an overview of systematic reviews," *BMC Medicine*, vol. 10, no. 1, p. 167, 2012.
- [19] B. D. Anne, S. Keith, and G. M. Hall, "Physiological effects of exercise," *Continuing Education in Anesthesia, Critical Care and Pain*, vol. 4, no. 6, pp. 185–188, 2004.
- [20] W. J. Kraemer and N. A. Ratamess, "Hormonal responses and adaptations to resistance exercise and training," *Sports Medicine (Auckland, NZ)*, vol. 35, no. 4, pp. 339–361, 2005.
- [21] M. A. Nystoriak and A. Bhatnagar, "Cardiovascular Effects and Benefits of Exercise," *Frontiers in Cardiovascular Medicine*, vol. 5, p. 5, 2018.
- [22] W. Geidl, K. Abu-Omar, M. Weege, S. Messing, and K. Pfeifer, "German recommendations for physical activity and physical activity promotion in adults with noncommunicable diseases," *The International Journal of Behavioral Nutrition and Physical Activity*, vol. 17, no. 1, p. 12, 2020.
- [23] WHO, *Global health estimates 2019: deaths by cause, age, sex, by country and by region, 2000–2019*, World Health Organization, 2019, Accessed 20 September 2022, <https://www.who.int/data/global-health-estimates>.
- [24] WHO, *Premature Deaths Due to NCDs* World Health Organization Accessed 20 September 2022, <https://www.who.int/data/gho/data/gho/data/themes/topics/topic-details/GHO/ncd-mortality>.
- [25] R. Menhas, J. Dai, M. A. Ashraf et al., "Physical inactivity, non-communicable diseases and national fitness plan of China for physical activity," *Risk Management and Healthcare Policy*, vol. 14, pp. 2319–2331, 2021.
- [26] Global Health Observatory (GHO), *data: Prevalence of insufficient physical activity* World Health Organization Accessed 20 September 2022, [http://www.who.int/gho/ncd/risk\\_factors/physical\\_activity/en](http://www.who.int/gho/ncd/risk_factors/physical_activity/en).
- [27] I. M. Lee, E. J. Shiroma, F. Lobelo et al., "Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy," *Lancet*, vol. 380, no. 9838, pp. 219–229, 2012.
- [28] H. H. Kyu, V. F. Bachman, L. T. Alexander et al., "Physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events: systematic review and dose-response meta-analysis for the Global Burden of Disease Study 2013," *British Medical Journal*, vol. 354, article i3857, 2016.
- [29] C. P. Wen and X. Wu, "Stressing harms of physical inactivity to promote exercise," *Lancet*, vol. 380, no. 9838, pp. 192–193, 2012.
- [30] D. Ding, K. D. Lawson, T. L. Kolbe-Alexander et al., "The economic burden of physical inactivity: a global analysis of major non-communicable diseases," *Lancet*, vol. 388, no. 10051, pp. 1311–1324, 2016.
- [31] R. Guthold, G. A. Stevens, L. M. Riley, and F. C. Bull, "Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1\*9 million participants," *The Lancet Global Health*, vol. 6, no. 10, pp. e1077–e1086, 2018.
- [32] C. Sfm, J. Van Cauwenberg, L. Maenhout, G. Cardon, E. V. Lambert, and D. Van Dyck, "Inequality in physical activity, global trends by income inequality and gender in adults," *The International Journal of Behavioral Nutrition and Physical Activity*, vol. 17, no. 1, p. 142, 2020.
- [33] P. C. Hallal, L. B. Andersen, F. C. Bull et al., "Global physical activity levels: surveillance progress, pitfalls, and prospects," *Lancet*, vol. 380, no. 9838, pp. 247–257, 2012.
- [34] Health and sport, "Central people's government of the People's Republic of China," 2020, Accessed 23 September 2022, [http://www.gov.cn/guoqing/2021-04/09/content\\_5598667.htm](http://www.gov.cn/guoqing/2021-04/09/content_5598667.htm).

- [35] Y. Zhu, J. Liu, B. Qu, and Z. Yi, "Quality of life, loneliness and health-related characteristics among older people in Liaoning province, China: a cross-sectional study," *BMJ Open*, vol. 8, no. 11, article e021822, 2018.
- [36] Q. Deng, Y. F. Wang, J. J. Zhu, and J. M. Zhou, "Status and influencing factors of physical activity among adults, Chengdu," *Modern Preventive Medicine*, vol. 48, no. 15, pp. 2791–2796, 2021.
- [37] Y. Fu, Q. Yuan, J. Wang et al., "Current status and influencing factors of overweight and obesity among natural population in Shenzhen," *Modern Preventive Medicine*, vol. 48, no. 16, pp. 2978–2982, 2021.
- [38] Y. P. Nian, Q. X. Wu, M. Z. Fu et al., "Physical activities and associated factors among resident, Pingshan district in Shenzhen," *Modern Preventive Medicine*, vol. 45, no. 7, 2018.
- [39] "International Physical Activity Questionnaire (IPAQ)—Short and Long Forms. International Physical Activity Questionnaire," Accessed 21 September 2022, [https://sites.google.com/site/theipaq/questionnaire\\_links](https://sites.google.com/site/theipaq/questionnaire_links).
- [40] "Guidelines for data processing and analysis of the international physical activity questionnaire. International Physical Activity Questionnaire," Accessed 21 September 2022, <https://sites.google.com/site/theipap/scoring-protocol>.
- [41] P. J. Ruiz-Montero, G. J. Ruiz-Rico Ruiz, R. Martín-Moya, and P. J. González-Matarín, "Do health-related quality of life and pain-coping strategies explain the relationship between older women participants in a Pilates-aerobic program and bodily pain? A multiple mediation model," *International Journal of Environmental Research and Public Health*, vol. 16, no. 18, p. 3249, 2019.
- [42] M. Gutiérrez, P. Calatayud, and J. M. Tomás, "Motives to practice exercise in old age and successful aging: a latent class analysis," *Archives of Gerontology and Geriatrics*, vol. 77, pp. 44–50, 2018.
- [43] C. L. Craig, A. L. Marshall, M. Sjöström et al., "International physical activity questionnaire: 12-country reliability and validity," *Medicine and Science in Sports and Exercise*, vol. 35, no. 8, pp. 1381–1395, 2003.
- [44] B. E. Ainsworth, W. L. Haskell, M. C. Whitt et al., "Compendium of physical activities: an update of activity codes and MET intensities," *Medicine and Science in Sports and Exercise*, vol. 32, Supplement, pp. S498–S516, 2000.
- [45] C. Shea, A. R. Khawaja, K. Sofi, and G. Nabi, "Association of metabolic equivalent of task (MET) score in length of stay in hospital following radical cystectomy with urinary diversion: a multi-institutional study," *International Urology and Nephrology*, vol. 53, no. 7, pp. 1305–1310, 2021.
- [46] T. Torres, J. M. Alexandre, D. Mendonça, C. Vasconcelos, B. M. Silva, and M. Selores, "Levels of physical activity in patients with severe psoriasis: a cross-sectional questionnaire study," *American Journal of Clinical Dermatology*, vol. 15, no. 2, pp. 129–135, 2014.
- [47] H. W. Kohl, C. L. Craig, E. V. Lambert et al., "The pandemic of physical inactivity: global action for public health," *Lancet*, vol. 380, no. 9838, pp. 294–305, 2012.
- [48] P. D. Thompson, R. Arena, D. Riebe, L. S. Pescatello, and American College of Sports Medicine, "ACSM's new preparticipation health screening recommendations from ACSM's guidelines for exercise testing and prescription," *Current Sports Medicine Reports*, vol. 12no. 4, pp. 215–217, 2013.
- [49] F. C. Bull, S. S. Al-Ansari, S. Biddle et al., "World Health Organization 2020 guidelines on physical activity and sedentary behaviour," *British Journal of Sports Medicine*, vol. 54, no. 24, pp. 1451–1462, 2020.
- [50] Y. K. Cheah and B. K. Poh, "The determinants of participation in physical activity in Malaysia," *Osong Public Health and Research Perspectives*, vol. 5, no. 1, pp. 20–27, 2014.
- [51] H. Y. Mao, H. C. Hsu, and S. D. Lee, "Gender differences in related influential factors of regular exercise behavior among people in Taiwan in 2007: a cross-sectional study," *PLoS One*, vol. 15, no. 1, article e0228191, 2020.
- [52] K. R. Devonshire-Gill and K. I. Norton, "Australian adult physical activity sufficiency trend data: positive, prevalent, and persistent changes 2002–2012," *Journal of Physical Activity & Health*, vol. 15, no. 2, pp. 117–126, 2018.
- [53] L. V. Bernardelli, C. Pereira, and M. A. Kortt, "The economic and social determinants of participation in physical activity in Brazil," *International Review of Applied Economics*, vol. 34, no. 2, pp. 252–266, 2020.
- [54] Y. K. Cheah, M. Azahadi, S. N. Phang, and N. J. M. Hazilah, "The income and demographic determinants of physical activity intensity: evidence from a developing country," *Margin: The Journal of Applied Economic Research*, vol. 11, no. 3, pp. 348–364, 2017.
- [55] Y. K. Cheah, M. Azahadi, S. N. Phang, and N. Hazilah, "Factors affecting participation decision and amount of physical activity among urban dwellers in Malaysia," *Public Health*, vol. 146, pp. 84–91, 2017.
- [56] L. Uijtendwilligen, G. M. Peeters, J. G. van Uffelen, J. W. Twisk, A. S. Singh, and W. J. Brown, "Determinants of physical activity in a cohort of young adult women. Who is at risk of inactive behaviour?," *Journal of Science and Medicine in Sport*, vol. 18, no. 1, pp. 49–55, 2015.
- [57] Y. K. Cheah, "Socioeconomic disparities in physical activity participation: an exploratory study using Malay sample," *Asia Pacific Social Science Review*, vol. 15, article e107, 2015.
- [58] F. Li, L. Mao, and P. Chen, "Physical activity and prevention of chronic disease in Chinese youth: a public health approach," *Journal of Sport and Health Science*, vol. 8, no. 6, pp. 512–515, 2019.
- [59] Z. Zhu, Y. Yang, Z. Kong, Y. Zhang, and J. Zhuang, "Prevalence of physical fitness in Chinese school-aged children: findings from the 2016 physical activity and fitness in China—the youth study," *Journal of Sport and Health Science*, vol. 6, no. 4, pp. 395–403, 2017.
- [60] L. F. Moreira, A. M. C. Filho, and J. De Amorim, "Association of physical performance impairments and limitations with insufficient physical activity among older adults in Brazil: results from the national health survey," *Journal of Public Health*, vol. 30, no. 4, pp. 781–788, 2022.
- [61] H. Singh, S. Singh, A. Singh, and J. S. Baker, "Physical activity levels among the adults of Majha region of Punjab, India: a cross-sectional study," *American Journal of Human Biology: the Official Journal of the Human Biology Council*, vol. 33, no. 6, article e23533, 2021.
- [62] U. M. Kujala, P. Hautasaari, H. Vähä-Ypyä et al., "Chronic diseases and objectively monitored physical activity profile among aged individuals - a cross-sectional twin cohort study," *Annals of Medicine*, vol. 51, no. 1, pp. 78–87, 2019.
- [63] A. Marques, M. Peralta, J. Martins, M. G. de Matos, and R. C. Brownson, "Cross-sectional and prospective relationship between physical activity and chronic diseases in European older adults," *International Journal of Public Health*, vol. 62, no. 4, pp. 495–502, 2017.

- [64] L. Forechi, J. G. Mill, R. H. Griep, I. Santos, F. Pitanga, and M. Molina, "Adherence to physical activity in adults with chronic diseases: ELSA-Brasil," *Revista de saude publica*, vol. 52, p. 31, 2018.
- [65] B. Loef, E. L. de Hollander, C. R. Boot, and K. I. Proper, "Physical activity of workers with and without chronic diseases," *Preventive Medicine Reports*, vol. 3, pp. 30–35, 2016.
- [66] B. R. Humphreys and J. E. Ruseski, "The economic choice of participation and time spent in physical activity and sport in Canada," *International Journal of Sport Finance*, vol. 10, article e138, 2015.
- [67] B. R. Humphreys and J. E. Ruseski, "An economic analysis of participation and time spent in physical activity," *B E Journal of Economic Analysis & Policy*, vol. 11, no. 1, p. 47, 2011.
- [68] B. K. Poh Jr., M. Y. Safiah, A. Tahir et al., "Physical activity pattern and energy expenditure of Malaysian adults: findings from the Malaysian adult nutrition survey (MANS)," *Malaysian Journal of Nutrition*, vol. 16, no. 1, pp. 13–37, 2010.
- [69] R. Patterson, E. Webb, C. Millett, and A. A. Laverty, "Physical activity accrued as part of public transport use in England," *Journal of Public Health*, vol. 41, no. 2, pp. 222–230, 2019.
- [70] "The national physical fitness monitoring center released the "2020 national fitness activities survey bulletin". General Administration of Sport of China," Accessed 23 September 2022, <https://www.sport.gov.cn/n315/n329/c24335053/content.html>.
- [71] M. Çule and H. Guliani, "Are there gender based differences in participation and time spent in physical activity in Albania? Evidence from 2017-18 demographic and health survey," *Archives of Public Health*, vol. 80, no. 1, p. 187, 2022.
- [72] E. Sebastião, S. Gobbi, W. Chodzko-Zajko et al., "The international physical activity questionnaire-long form overestimates self-reported physical activity of Brazilian adults," *Public Health*, vol. 126, no. 11, pp. 967–975, 2012.
- [73] M. Wanner, N. Probst-Hensch, S. Kriemler, F. Meier, C. Autenrieth, and B. W. Martin, "Validation of the long international physical activity questionnaire: influence of age and language region," *Preventive Medicine Reports*, vol. 3, pp. 250–256, 2016.
- [74] C. Liang, Z. Zheng, Y. Wu et al., *Physical Activity among Rural Residents in Eastern, A Cross-Sectional Survey*. Preprints, Central and Western Provinces of China, 2022.