Leisure Time Physical Activity and Hypertension: Evidence from the China Health & Nutrition Survey, 2004-2011

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Abstract

Background: The prevalence of hypertension has dramatically increased in the past several decades in China. At the same time, the level of physical activity among Chinese has significantly reduced. The association between leisure time physical activity and development of hypertension has not been thoroughly established, especially from an urban-rural perspective. The study thus sought to examine the associations in Chinese adults using longitudinal data, and the association’s difference in urban and rural community.

Methods: A total of 2,687 adults were included in the analysis. Multivariate logistic regressions and proportional hazard regressions were performed to assess the association after adjusting for possible confounding variables. Urban-rural differences were also investigated by stratified analysis.

Results: In the sample, 62.3% were from urban, 47.4% were men, and the mean age was 40. Adjusted estimates show that leisure time activity was a significant protector from developing hypertension (HR=0.60, 95% CI=0.41-0.87) in Chinese sample. The correlation was found to be significant among urban residents (HR=0.57, 95% CI=0.38-0.87), but not in rural participants (HR=0.91, 95% CI=0.36-2.33).

Conclusions: Leisure time physical activity and development of hypertension were significantly correlated with each other in Chinese. Promoting leisure time physical activity may be helpful in hypertension prevention and control in China. In addition, educating healthy diet and occupational physical activity pattern might be helpful in urban areas.

Keywords: China health and nutrition survey; Physical activity; Hypertension; Urban and rural disparities

Introduction

Leisure time physical activity and hypertension

Since the industrial revolution, the development and use of new technologies have enabled people to reduce the amount of physical activity needed to accomplish many tasks in their daily lives [1]. However, physical inactivity has contributed to the worldwide epidemic of obesity and related non-communicable diseases [2]. It was identified as one of the leading risk factors for non-communicable diseases and contributed to more than 3 million preventable deaths [3]. Compared to other populations in the world, Chinese people are relatively physically active [1,4], and spend more time walking than people from Western countries and Mediterranean populations [5]. Nevertheless, many studies revealed that the amount of time people spend in regular physical activity has been declining continuously in China [5,6].

Hypertension, an important non-communicable disease risk factor, is highly prevalent in many countries [7]. A recently study found that the prevalence of hypertension among adults in Canada, the United States, and England was 19.5%, 29.1%, and 30.0%, respectively [8]. In many low-income and middle-income countries, partly due to the lack of comprehensive interventions such as care managers [9], hypertension might be even more common. For example, during 2007 to 2010, the prevalence rate was as high as 52.9% among older populations in countries including China, Ghana, India, Mexico, the Russian Federation and South Africa [7]. The rates of hypertension are increasing. In China alone, studies suggest that the prevalence of hypertension has increased from 5.0% in 1959 to nearly 19.0% in 2002, and to 26.6% in 2008 [10,11].

Reasons for the increasing prevalence of hypertension in China are still unclear, but studies conducted in other countries have suggested that reduction in physical activity associated with urbanization has played an important role [12,13]. Given the tremendous transitions in China's economy and associated life style changes in the past four decades, it is important to assess changes in physical activity among Chinese and how these changes might be related to the incidence of hypertension.

The urban-rural disparities

In China, urban residents were more likely to be overweight and obese, relative to their rural counterparts [14-18]. Also, urban adults had a higher chance of developing cardiovascular diseases and had
higher cardiovascular diseases related mortality rate than their rural counterparts [14,19,20].

In terms of leisure time physical activities, urban and rural disparities still exist. Specifically, urban adults were more physically active than their rural counterparts [21], as TV ownership increased more in rural areas, compared to urban areas [19,20]. But there is no evidence showing that leisure time physical activities have increased significantly in urban residents.

In light of substantial urban-rural disparities in leisure time physical activity patterns, changes in leisure time activity, and prevalence of obesity and cardiovascular disease in China, this study seeks to assess the association between leisure time physical activity and incidence of hypertension in urban and rural residents separately by conducting stratified analyses. Considering rural residents have a healthier diet and are involved in more vigorous occupational physical activity [19,22], it is hypothesized that leisure time physical activity is a significant protector against developing hypertension in urban residents only.

Methods

Research population

The source of data comes from the China Health and Nutrition Survey (CHNS). The survey adopted a multistage, random cluster sampling to draw a representative sample of about 4,400 households with a total of 26,000 individuals in nine provinces in China that vary substantially in geography, economic development, public resources, and health indicators.

The survey collected data every two or three years starting from 1989. It recruited most participants in Year of 2011 (also the latest available data is from 2011), and most of them were followed-up from Year of 2004. Furthermore, 7 years (2004 to 2011) is a reasonable time period to observe the development of hypertension under the possible impact of exposure such as physical inactivity. The study thus used the CHNS data from the two specific years. There were 8,969 adults in 2004 and 12,235 in 2011. The base population of the study included 5,685 participants who participated in both the 2004 survey and 2011 survey, which means 3,284 out of 8,969 participants in 2004 were lost for follow-up. Since 2,998 participants did not express preference on physical activities in 2004, the sample size for data analysis was 2,687.

Part of the sample attrition could be due to substantial migration out of rural China since the 1980s. The young, aged from 15 to 40, make up a large proportion of participants that dropped out of the study between 2004 and 2011 [23]. Nevertheless, other studies have suggested that the potential bias associated with the attrition should not be a grave concern, because among large-scale surveys in developing countries, the CHNS is one of the most successful panel studies with relatively low attrition rates [24,25].

Measurements

Leisure time physical activity behavior: Participants were asked in the survey if they participate in the following activities during leisure time: Martial arts (Kung Fu, etc.); Gymnastics, dancing, acrobatic; Track and field (running, etc.), swimming; Soccer, basketball, tennis; Badminton, volleyball; Other (ping pong, Tai Chi, etc.). If they answered “yes” to any of those activities, their responses would be coded as 1, otherwise 0.

Hypertension: Participants were asked: “Has a doctor ever told you that you suffer from high blood pressure?” to identify if they had any doctor-diagnosed hypertension. Then, participants further indicated how many years they have had hypertension if they answered “yes” to the question mentioned above. Those who have had hypertension over seven years in 2011 were excluded from the study because their hypertension was diagnosed before the start of the study period – 2004. Previous studies have shown the validity of self-reported physician-diagnosed chronic diseases [26].

Potential confounding variables: Potential confounding variables were measured in 3 constructs: sociodemographic variables, health behaviors, and health-related variables. Sociodemographic variables include age, sex, ethnicity, marital status, community types (urban vs. suburban vs. town vs. village), region of residence (north vs. south), education, employment status, and annual household income (Chinese Yuan Rennminbi - RMB; Yuan-US Dollar exchange rate was 6.4588 Yuan per U.S dollar in 2011; annual household income was grouped into four levels according to quartiles: 0-8000, 8001-15000, 15001-25000, and over 25000). Region of residence was divided into north and south based on Huai River policy, since a previous study has shown 5.5 years of disparity in terms of life expectancy between north and south China [27]. Health behaviors were indicated by smoking status (do you smoke cigarettes now?) and alcohol consumption (do you drink beer or any other alcoholic beverage?). Health-related variables included current health status (self-report), health insurance coverage, and Body Mass Index (BMI). A unique BMI criterion was applied recognizing that Chinese have different body shapes and skeletons compared to westerners, as a growing number of studies have revealed that Chinese and several populations from other Asian Pacific countries have an increased risk for obesity-related chronic diseases or conditions at a lower BMI than Caucasians [28-33]. In the Chinese BMI criterion, underweight is <18.50, normal weight is 18.50-23.99, overweight is 24.00-27.99, and obesity is 28.00 and over [34].

Statistical analysis

A univariate analysis was conducted to depict the distribution of all explanatory and control variables. Chi-square ($\chi^2$) tests were used for assessing the association between categorical variables leisure time physical activity behavior and development of hypertension.

The association between leisure time physical activity behavior and incidence of hypertension was further assessed by proportional hazards regressions adjusting for possible confounding variables. Additionally, to explore potential urban-rural differences, analyses were conducted separately for urban residents and rural residents. To test for possible mediation through BMI and current health status (self-report), models were run with and without these mediating variables. Hazards ratios and 95% confidence intervals (95% CIs) were reported. The association was considered to be significant if the 2-sided p value is less than 0.05. Analyses were performed using the SPSS for Windows, version 21.0 [35].

Results

Table 1 shows descriptive statistics for all outcome variables and covariates. Overall, incidence of hypertension was high (12.6%), and it was higher among urban residents (13.9%) than their rural counterparts (10.7%). Participants did not actively participate in leisure time physical activity in 2004 (14.9%); urban residents were substantially more likely than rural citizens to report leisure time
physical activity behavior (20.7% vs. 5.9%). In terms of ethnic composition, Han dominated the sample, which is consistent with the national ethnic distribution in China. Unemployment rate was substantially higher in urban residents than among rural participants (26.9% vs. 8.9%).

Annual household income was higher among urban people. Specifically, there were more urban residents with income of 15001-25000 Yuan (23.2% vs. 22.6%) and over 25000 Yuan (39.1% vs. 19.6%), and less urban participants with income of 0-8000 Yuan (15.4% vs. 28.4%) and 8001-15000 Yuan (22.3% vs. 29.3%). In terms of educational attainment, less than one third (30.5%) of the sample received a high school or above education. About forty percent (40.1%) of urban residents reported high school of above education, as compared to only 15.5% among rural residents. Nearly 38.9% of the whole sample was from rural areas, while 61.1% was from urban areas. Urban residents tended to have higher Body Mass Index (BMI); specifically, they were less likely to be underweight (3.4% vs. 5.2%) and have normal weight (51.3% vs. 59.0%), and were more likely to be overweight (35.8% vs. 29.2%) and obese (9.5% vs. 6.6%) compared to rural participants. They (urban residents) were more likely to be covered by health insurance than rural people (42.6% vs. 21.8%).

| Variables                      | Whole Sample | Urban Residents | Rural Residents |
|--------------------------------|--------------|-----------------|-----------------|
|                               | Number       | Mean or Percentage (SD) | Number | Mean or Percentage (SD) | Number | Mean or Percentage (SD) |
| Dependent variable (2011)     |              |                  |                  |                  |                  |
| Hypertension                  |              |                  |                  |                  |                  |
| No                             | 2123         | 87.4             | 1278            | 86.1             | 845             | 89.3             |
| Yes                            | 307          | 12.6             | 206             | 13.9             | 101             | 10.7             |
| Independent variables (2004)  |              |                  |                  |                  |                  |
| Leisure time activity behavior|              |                  |                  |                  |                  |
| Leisure time activity         |              |                  |                  |                  |                  |
| No                             | 2052         | 85.1             | 1168            | 79.3             | 884             | 94.1             |
| Yes                            | 360          | 14.9             | 305             | 20.7             | 55              | 5.9              |
| Demographics                  |              |                  |                  |                  |                  |
| Age                            | 2412         | 39.62 (12.51)    | 1487            | 41.25 (13.06)    | 948             | 37.07 (11.15)    |
| Sex                            |              |                  |                  |                  |                  |
| Male                           | 1156         | 47.5             | 697             | 46.9             | 459             | 48.4             |
| Female                         | 1279         | 52.5             | 790             | 53.1             | 489             | 51.6             |
| Ethnicity                      |              |                  |                  |                  |                  |
| Han                            | 2192         | 90               | 1369            | 92.1             | 823             | 86.8             |
| Others                         | 243          | 10               | 118             | 7.9              | 125             | 13.2             |
| Marital status                 |              |                  |                  |                  |                  |
| Never married                  | 107          | 4.4              | 71              | 4.8              | 36              | 3.8              |
| Married                        | 2257         | 93.1             | 1367            | 92.4             | 890             | 94.3             |
| Divorced                       | 14           | 0.6              | 10              | 0.7              | 4               | 0.4              |
| Widowed                        | 46           | 1.9              | 32              | 2.2              | 14              | 1.5              |
| Community types                |              |                  |                  |                  |                  |
| Urban                          | 425          | 17.5             | 425             | 28.6             | -               | -                |
| Suburban                       | 578          | 23.7             | 578             | 38.9             | -               | -                |
| Town                           | 484          | 19.9             | 484             | 32.5             | -               | -                |
| Village                        | 948          | 38.9             | -               | -                | 948             | 100              |

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| Region of residence |       |       |       |       |       |
|---------------------|-------|-------|-------|-------|-------|
| North               | 1149  | 47.2  | 657   | 44.2  | 492   | 51.9  |
| South               | 1286  | 52.8  | 830   | 55.6  | 456   | 48.1  |

| Socioeconomic status |       |       |       |       |
|----------------------|-------|-------|-------|-------|
| Employment           |       |       |       |       |
| Unemployed           | 484   | 19.9  | 400   | 26.9  | 84    | 8.9   |
| Employed             | 1948  | 80.1  | 1085  | 73    | 863   | 91.1  |
| Annual household income (Yuan) |   |       |       |       |       |
| 0-8000               | 492   | 20.5  | 227   | 15.4  | 265   | 28.4  |
| 8001-15000           | 602   | 25    | 329   | 22.3  | 273   | 29.3  |
| 15001-25000          | 552   | 23    | 341   | 23.2  | 211   | 22.6  |
| Over 25000           | 759   | 31.6  | 576   | 39.1  | 183   | 19.6  |
| Education            |       |       |       |       |       |
| Illiterate           | 410   | 16.9  | 200   | 13.5  | 210   | 22.2  |
| Primary school       | 551   | 22.7  | 258   | 17.4  | 293   | 30.9  |
| Middle school        | 726   | 29.9  | 429   | 29    | 297   | 31.4  |
| High school or above | 740   | 30.5  | 593   | 40.1  | 147   | 15.5  |

| Health behavior      |       |       |       |       |
|----------------------|-------|-------|-------|-------|
| Smoking status        |       |       |       |       |
| Nonsmoker            | 1622  | 66.7  | 1002  | 67.4  | 620   | 65.5  |
| Smoker               | 810   | 33.3  | 484   | 32.6  | 326   | 34.5  |
| Alcohol consumption   |       |       |       |       |
| No drinking          | 1587  | 65.2  | 950   | 63.9  | 637   | 67.2  |
| Drinking             | 848   | 34.8  | 537   | 36.1  | 311   | 32.8  |

| Health-related variables |       |       |       |       |       |
|--------------------------|-------|-------|-------|-------|-------|
| BMI categories           |       |       |       |       |       |
| Underweight              | 94    | 4.1   | 48    | 3.4   | 46    | 5.2   |
| Normal weight            | 1248  | 54.2  | 728   | 51.3  | 520   | 59    |
| Overweight               | 766   | 33.3  | 509   | 35.8  | 257   | 29.2  |
| Obese                    | 193   | 8.4   | 135   | 9.5   | 58    | 6.6   |

| Current health status (self-report) |       |       |       |       |       |
|-------------------------------------|-------|-------|-------|-------|-------|
| Very good                           | 411   | 16.9  | 227   | 15.3  | 184   | 19.5  |
| Good                                | 1118  | 46    | 710   | 47.8  | 408   | 43.1  |
| Bad                                 | 778   | 32    | 478   | 32.2  | 300   | 31.7  |
| Very bad                            | 124   | 5.1   | 70    | 4.7   | 54    | 5.7   |

| Health insurance coverage |       |
|---------------------------|-------|
Table 1: Variables in analysis of leisure time physical activity behavior and incidence of hypertension in the sample (n=2,213), urban (n=1,367) and rural (n=846) residents.

Table 2 shows the bivariate associations between leisure time physical activity behavior in 2004 and incidence of hypertension in 2011. Physical activity behavior was marginally significantly related to incidence of hypertension among the whole sample ($\chi^2=2.064, p<0.10$), and the association was significant among urban residents only ($\chi^2=3.734, p<0.05$), but not among rural residents. In the whole sample, 13.0% of those who did not perform physical activity in 2004 were diagnosed as having hypertension in 2011, while only 10.3% of those with physical activity later developed hypertension. The discrepancy was more substantial in urban residents (14.8% vs. 10.5%). Although the pattern was observed in rural residents (10.7% vs. 9.1%), the difference was minimal and the association between leisure time physical activity and incidence of hypertension was not significant ($p>0.10$).

Table 2: Bivariate associations between leisure time physical activity behavior in 2004 and incidence of hypertension between 2004 and 2011 among sample (n=2,213), urban (n=1,367) and rural (n=846) residents.

Table 3 shows the proportional hazards models assessing the association between leisure time physical activity behavior in 2004 and the incidence of hypertension in 2011. Leisure time physical activity behavior was a significant protector from incidence of hypertension in the whole sample (HR=0.60, 95% CI=0.41-0.87) and urban residents (HR=0.57, 95% CI=0.38-0.87), but not among rural residents (HR = 0.91, 95% CI=0.36-2.33). Specifically, the hypertension hazard was reduced by 40% (1-0.60) in the whole sample and 43% (1-0.57) in the urban residents for those who performed leisure time physical activity versus those who did not do so. Age was also significantly associated with higher probability of hazard of hypertension in the whole sample (HR=1.03, 95% CI=1.02-1.04), urban sample (HR=1.03, 95% CI=1.01-1.04), and rural residents (HR=1.04, 95% CI=1.02-1.07). Notably, participants with higher BMI tend to have a higher hypertension hazard. Specifically, the hypertension hazard for those who were overweight were 5.52 times (95% CI=2.02-15.10) in the whole sample, 5.34 times (95% CI=1.30-22.03) in urban residents, and 6.40 times (95% CI=1.51-27.19) among rural residents than that of underweight participants. When comparing the hazard of obese participants to that of underweight participants, those number were 5.70 (95% CI=2.01-16.13), 5.73 (95% CI=1.35-24.44), and 7.25 (95% CI=1.54-34.26) in the whole sample, urban sample, and rural sample, respectively.

Table 3: Proportional hazards models assessing the association between leisure time physical activity behavior in 2004 and the incidence of hypertension in 2011.

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## Leisure time physical activity behavior

| Leisure time activity in 2004 | 0.60*** (0.41–0.87) | 0.57*** (0.38–0.87) | 0.91 (0.36–2.33) |

## Demographics

| Age | 1.03*** (1.02–1.04) | 1.03*** (1.01–1.04) | 1.04*** (1.02–1.07) |

| Sex | | | |

| Male | [1] | [1] | [1] |
| Female | 1.00 (0.71–1.40) | 1.04 (0.68–1.60) | 0.93 (0.51–1.70) |

## Ethnicity

| Han | [1] | [1] | [1] |
| Others | 0.74 (0.46–1.19) | 0.89 (0.49–1.62) | 0.62 (0.28–1.36) |

## Marital status

| Never married | [1] | [1] | [1] |
| Married | 2.10 (0.77–5.75) | 7.54** (1.04–54.50) | 0.48 (0.14–1.68) |
| Divorced | 0.00 (0.00–0.00) | 0.00 (0.00–0.00) | 0.00 (0.00–0.00) |
| Widowed | 1.20 (0.32–4.52) | 4.81 (0.54–43.08) | 0.13 (0.01–1.63) |

## Community types

| Urban | [1] | - | - |
| Suburban | 0.97 (0.68–1.38) | - | - |
| Town | 0.70* (0.48–1.03) | - | - |
| Village | 0.73 (0.50–1.07) | - | - |

## Region of residence

| North | [1] | [1] | [1] |
| South | 1.36** (1.06–1.74) | 1.24 (0.91–1.67) | 1.51* (0.97–2.33) |

## Socioeconomic status

### Employment

| Unemployed | [1] | [1] | [1] |
| Employed | 1.26 (0.91–1.76) | 1.18 (0.82–1.72) | 1.15 (0.50–2.61) |

### Annual household income (Yuan)

| 0-8000 | [1] | [1] | [1] |
| 8001-15000 | 0.87 (0.62–1.22) | 0.65* (0.42–1.02) | 1.31 (0.77–2.23) |
| 15001-25000 | 0.72* (0.49–1.04) | 0.65* (0.41–1.03) | 0.77 (0.39–1.51) |
| Over 25000 | 0.84 (0.59–1.18) | 0.74 (0.48–1.14) | 1.05 (0.56–1.97) |

### Education

| Illiterate | [1] | [1] | [1] |
| Primary school | 1.02 (0.73–1.45) | 1.02 (0.66–1.60) | 1.07 (0.61–1.88) |
| Middle school | 0.79 (0.54–1.16) | 0.75 (0.47–1.21) | 0.81 (0.42–1.55) |
Table 3: Hazards ratios for hypertension based on multivariate regressions among sample (n=2,213), urban (n=1,367) and rural (n=846) residents.

| Health behavior | 0.69* (0.48–1.04) | 0.63* (0.39–1.04) | 0.80 (0.36–1.76) |
|-----------------|-------------------|-------------------|------------------|
| Smoking status |                  |                   |                  |
| Nonsmoker       | [1]               | [1]               | [1]              |
| Smoker          | 1.01 (0.74–1.39)  | 1.21 (0.81–1.80)  | 0.73 (0.42–1.27) |
| Alcohol consumption |              |                   |                  |
| No drinking     | [1]               | [1]               | [1]              |
| Drinking        | 1.15 (0.85–1.56)  | 1.08 (0.75–1.56)  | 1.16 (0.68–1.99) |
| Health-related variables |          |                   |                  |
| BMI categories |                  |                   |                  |
| Underweight     | [1]               | [1]               | [1]              |
| Normal weight   | 2.42* (0.89–6.63) | 2.60 (0.63–10.78) | 2.48 (0.59–10.49) |
| Overweight      | 5.52* (2.02–15.10)| 5.34* (1.30–22.03)| 6.40* (1.51–27.19)|
| Obese           | 5.70*** (2.01–16.13)| 5.73* (1.35–24.44)| 7.25* (1.54–34.26)|
| Current health status (self-report) | | | |
| Very good       | [1]               | [1]               | [1]              |
| Good            | 0.98 (0.69–1.41)  | 0.92 (0.60–1.42)  | 1.04 (0.54–2.00) |
| Bad             | 1.02 (0.70–1.49)  | 0.87 (0.55–1.38)  | 1.29 (0.65–2.53) |
| Very bad        | 1.14 (0.65–1.99)  | 0.73 (0.34–1.57)  | 2.20* (0.93–5.21) |
| Health insurance coverage |          |                   |                  |
| No              | [1]               | [1]               | [1]              |
| Yes             | 1.19 (0.91–1.55)  | 1.15 (0.83–1.59)  | 1.39 (0.87–2.23) |

CI: confidence interval; BMI: Body Mass Index; —: not applicable; *p<0.10; **p<0.05; ***p<0.01; [1]: Reference

Figure 1 shows the mediation effects of BMI and current health status (self-report). After removing them, hazard ratios and 95% CI increased very slightly.

Discussion

This study explored the association between leisure time physical activity behavior and incidence of hypertension among adults who participated in the China Health & Nutrition Survey in 2004 and 2011. Overall, the incidence rate of hypertension over the 7 year-span in the sample was high (12.6%) [10,11]. The rate of leisure time physical activity was low in the sample (14.9%), which is consistent with previous studies [5,6]. In addition, the results reveal that leisure time physical activity behavior was a significant protector from developing hypertension after a 7 year period, which supports the original hypothesis, but only in urban residents, and not in rural participants.

People who were physically active experienced at least 40% (43% in urban residents) less risk of hypertension when compared with who were not, which is supported by previous studies [36-38]. Although the pathway from lack of physical activity to hypertension is still unclear [36], confirming the causal relationship is essential, especially among the Chinese population who is experiencing a significant transition in terms of physical activity level and hypertension prevalence.

The urban-rural difference was substantial in the study. First, leisure time physical activity was significantly higher among urban residents than their rural counterparts. The reason could be the urban residents had more access to facilities and more opportunities for physical activity than those in the rural areas [39,40]. Second, the incidence of diagnosed hypertension was also higher in urban sample. Possibly, the difference is because chronic diseases, such as hypertension, remained largely undiagnosed, and the rate of undiagnosed hypertension was higher in rural residents as compared to their urban counterparts [11,14,41]. Alternatively, this may be due to unadjusted mediating effects (rural residents tend to have a healthier diet and be involved in...
more vigorous occupational physical activity [42,43]). Third, the significant association between leisure time physical activity behavior and incidence of hypertension was found in urban residents, but not in rural participants. Again, healthier diet and more vigorous occupational physical activity among rural residents might have diminished the association.

![Figure 1: Comparison of hazards ratios and 95% CI of incidence of hypertension with and without mediators.](image)

This study has several limitations. First, the data contained no qualitative data. Thus, one cannot disentangle why and how physical activity behavior impacts incidence of hypertension. Additionally, several important covariates (such as diet or occupational physical activity) were not included in the models due to the lack of availability of data. Finally, this study was based on a sample in China, where cultural norms and patterns of physical activity may be unique to the context, which limits the generalizability of the findings to other countries.

Despite these limitations, this population-based study is unique. First, to our knowledge, it is the first study in China using longitudinal data to detect the effect of leisure time physical activity on incidence of hypertension. Second, it sheds light on the urban-rural disparities in terms of leisure time physical activity and its relationship with the incidence of hypertension.

Furthermore, our major finding that leisure time physical activity in Chinese adults is a significant protector from hypertension, has implications for policy and health promotion interventions. For example, community health interventions focusing on decreasing disparities may imply that future interventions can be tailored to the context, which limits the generalizability of the findings to other countries.

**References**

1. Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, et al. (2012) Global physical activity levels: surveillance progress, pitfalls, and prospects. Lancet 380: 247-257.
2. Alwan A (2011) Global status report on noncommunicable diseases 2010. World Health Organization.
3. World Health Organization (2009) Global health risks: mortality and burden of disease attributable to selected major risks.
4. Deng HB, Macfarlane D, Thomas G, Lao X, Jiang C, et al. (2008) Reliability and validity of the ipaq-chinese: the guangzhou biobank cohort study. Med Sci Sport Exer 40: 303.
5. Ng SW (2009) Understanding changes in diet, physical activity and weight among adults in China. The University of North Carolina at Chapel Hill pp: 148.
6. Sallis JP, Alcaraz JE, McKenzie TL, Hovell MF (1999) Predictors of change in children's physical activity over 20 months: variations by gender and level of adiposity. Am J Prev Med 16: 222-229.
7. Lloyd-Sherlock P, Beard J, Minicucci N, Ebrahim S, Chatterji S (2014) Hypertension among older adults in low-and middle-income countries: prevalence, awareness and control. Int J Epidemiol 43: 116-128.
8. Joffres M, Falaschetti E, Gillespie C, Robitaille C, Lousalot F, et al. (2013) Hypertension prevalence, awareness, treatment and control in national surveys from England, the USA and Canada, and correlation with stroke and ischaemic heart disease mortality: a cross-sectional study. BMJ open 3: e003423.
9. Ciccone MM, Aquilino A, Cortese F, Scicchitano P, Sassara M, et al. (2010) Feasibility and effectiveness of a disease and care management model in the primary health care system for patients with heart failure and diabetes (Project Leonardo). Vascular Health and Risk Management 6: 297-305.
10. Gao Y, Chen G, Tian H, Lin L, Lu J, et al. (2013) Prevalence of hypertension in China: a cross-sectional study. PLoS One 8: e69398.
11. Wu Y, Huxley R, Li L, Anna V, Xie G, et al. (2008) Prevalence, awareness, treatment, and control of hypertension in China data from the China National Nutrition and Health Survey 2002. Circulation 118: 2679-2686.
12. Janus ED, Postiglione A, Singh RB, Lewis B (1996) The modernization of Asia implications for coronary heart disease. Circulation 94: 2671-2673.
13. Popkin BM (1999) Urbanization, lifestyle changes and the nutrition transition. World Dev 27: 1905-1916.
14. Hou X (2008) Urban—rural disparity of overweight, hypertension, undiagnosed hypertension, and untreated hypertension in China. Asia-Pac J Public He 20: 159-169.
15. Ma G, Li Y, Wu Y, Zhai F, Cui Z, et al. (2005) Family average overweight and obesity and its changes among Chinese people during 1992 to 2002. Zhonghua yu fang yi xue za zhi 39: 311-315.
16. Reynolds K, Gu D, Whelton PK, Wu X, Duan X, et al. (2007) Prevalence and risk factors of overweight and obesity in China. Obesity 15: 10-8.
17. Wang Y, Mi J, Shan X, Wang QJ, Ge K (2007) Is China facing an obesity epidemic and the consequences? The trends in obesity and chronic disease in China. Int J Obesit 51: 177-188.
18. Xu F, Yin XM, Zhang M, Leslie E, Ware R, et al. (2005) Family average income and body mass index above the healthy weight range among urban and rural residents in regional Mainland China. Public Health Nutr 8: 47-51.
19. Du S, Lu B, Zhai F, Popkin BM (2002) A new stage of the nutrition transition in China. Public Health Nutr 5: 169-174.
20. Yang G, Kong L, Zhao W, Wan X, Zhai Y, et al. (2008) Emergence of chronic non-communicable diseases in China. Lancet 372: 1697-1705.
21. Bauman A, Ma G, Guevas F, Omar Z, Wasoniwalu T, et al. (2011) Cross-national comparisons of socioeconomic differences in the prevalence of leisure-time and occupational physical activity, and active commuting in six Asia-Pacific countries. J Epidemiol Commu I H 65: 35-43.
22. Ding D, Sallis JF, Hovell MF, Du J, Zheng M, et al. (2011) Physical activity and sedentary behaviours among rural adults in suixi, china: a cross-sectional study. Int J Behav Nutr Phys Act 8: 37.
23. Zhang Y, Lam M, Lam J, Nan H, Sui Y, et al. (2012) Depression and risk factor control in chinese patients with type 2 diabetes. Diabetes 61: A373.
24. Thomas D, Frankenberg E, Smith JP (2001) Lost but not forgotten: Attrition and follow-up in the Indonesia Family Life Survey. J Hum Resour 36: 556-592.
25. Zhao Z (2007) Earnings instability and earnings inequality in urban China: 1989-2006.
26. Kehoe R, Wu SY, Leske MC, Chylack LT (1994) Comparing self-reported and physician-reported medical history. Am J Epidemiol 139: 813-818.
27. Chen Y, Ebenstein A, Greenstone M, Li H (2013) Evidence on the impact of sustained exposure to air pollution on life expectancy from China's Huai River policy. P Natl Acad Sci 110: 12936-12941.
28. Bassett J, WHO (2000) The Asia-Pacific perspective: redefining obesity and its treatment. Health Commun Aust.
29. Bei-Fan Z, The Cooperative Meta-analysis Group of Working Gro (2002) Predictive values of body mass index and waist circumference for risk factors of certain related diseases in Chinese adults: study on optimal cut-off points of body mass index. Asia Pac J Clin Nutr 11: S685.
30. Deurenberg-Yap M, Deurenberg P (2003) Is a re-evaluation of WHO body mass index cut-off values needed? The case of Asians in Singapore. Nutr Rev 61: 580-587.
31. Misra A (2003) Revisions of cutoffs of body mass index to define overweight and obesity are needed for the Asian-ethnic groups. Int J Obesity 27: 1294-1296.
32. WHO Expert Consultation (2004) Appropriate body-mass index cut-off values for Asian populations and its implications for policy and intervention strategies. Lancet 363: 157-163.
33. Zhou J, Kessler AS, Su D (2016) Association between daytime napping and chronic diseases in china. Am J Health Behav 40: 182-193.
34. Criteria of weight for adults (2013) WS/T 428-2013. China's State Family Planning Commission, Beijing.
35. SPSS (2012) SPSS statistics. IBM Corp, New York.
36. Howard AG, Gordon-Larsen P, Herring A, Du S, Popkin B (2014) The Role of Physical Activity in the Hypertension Pathway: A longitudinal pathway-based analysis across 18 years in modernizing China. Circulation 129: A62.
37. Hu G, Barengo NC, Tuomilehto J, Lakka TA, Nissinen A, et al. (2004) Relationship of physical activity and body mass index to the risk of hypertension: a prospective study in Finland. Hypertension 43: 25-30.
38. Ma G, Luan D, Li Y, Liu A, Hu X, et al. (2008) Physical activity level and its association with metabolic syndrome among an employed population in China. Obes Rev 1: 113-118.
39. Loucaides CA, Chedzoy SM, Bennett N (2004) Differences in physical activity levels between urban and rural school children in Cyprus. Health Educ Res 19: 138-147.
40. Sheu-jen H, Wen-chi H, Patricia AS, Jackson PW (2010) Neighborhood environment and physical activity among urban and rural schoolchildren in Taiwan. Health Place 16: 470-476.
41. Zhao Y, Hu Y, Smith JP, Strauss J, Yang G (2012) Cohort profile: The China health and retirement longitudinal study (CHARLS). Int J Obesity 43: 61-68.
42. Abu-Omar K, Rutten A (2008) Relation of leisure time, occupational, domestic, and commuting physical activity to health indicators in Europe. Prev Med 47: 319-323.
43. Hollermann A, Hansen J, Burr H, Sogaard K, Sjøgaard G (2012) The health paradox of occupational and leisure-time physical activity. Brit J Sport Med 46: 291-295.