

Associations Between Sedentary Behavior, Physical Activity, and Out-of-Pocket Health Care Expenditure: Evidence From Chinese Older Adults

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Objective: This study examined the associations between sedentary behavior, physical activity, and health care expenditures among Chinese older adults. **Method:** We conducted a survey on 4,165 older men and women living in major cities in China. Sedentary behavior and physical activity were measured by the Physical Activity Scale for the Elderly questionnaire. Health care costs were assessed by self-reported out-of-pocket health care expenditures across outpatient care, inpatient care, medication, and formal caregiver expenses. **Results:** Sedentary behavior was associated with an increase in annual out-of-pocket health care expenditures by approximately USD\$37 for each additional sedentary hour ($p < .001$). Physical activity was associated with a decrease in annual health care expenditures by approximately USD\$1.2 for each one Physical Activity Scale for the Elderly score ($p < .001$). Physical activity was a less salient indicator of health care expenditure for men than women. **Conclusions:** Reducing sedentary behavior among older men and women and promoting physical activity, especially among men, may be important strategies to reduce out-of-pocket health care expenditures in China.

Keywords: China, sex differences

As life expectancy increases, population aging has become an important focus of global health. Aging is associated with increased burden of chronic diseases and increased health care costs. This is an important challenge to global economic stability in the 21st century (Prince et al., 2015). Both sedentary behavior and physical activity are independently linked to chronic diseases and conditions. Sedentary behavior is defined as any behavior that maintains a low energy expenditure, such as sitting or reclining (Owen, Healy, Matthews, & Dunstan, 2010). Sedentary behavior has been linked to adverse health effects (Katzmarzyk, 2010; Owen, Healy, et al., 2010; Owen, Sparling, Healy, Dunstan, & Matthews, 2010) including an increased risk of all-cause mortality, metabolic syndrome, and obesity among older adults (de Rezende, Rey-Lopez, Matsudo, & Luiz, 2014). A recent review reported that sedentary behavior could increase the rate of all-cause dementia worldwide and impair cognitive function (Falck, Davis, & Liu-Ambrose, 2017). On the other hand, the benefits of physical activity for older adults include prevention and management of chronic diseases, such as coronary heart disease, hypertension, obesity, and osteoarthritis (Mazzeo et al., 1998). These are in addition to the psychological and social benefits of physical activity such as improved self-concept, enhanced self-esteem, and better quality of life (Chodzko-Zajko et al., 2009).

The economic consequences of physical inactivity have become an important topic for researchers and public health policymakers (Pratt, Epping, & Dietz, 2009; Pratt, Norris, Lobelo, Roux, & Wang, 2014). Previous research has reported that physical inactivity has contributed to 1.5–3.0% of total health care costs among different health systems worldwide (Katzmarzyk & Janssen, 2004; Pratt et al., 2014). For example, Ding et al. (2016) estimated that in 2013,

physical inactivity increased the health care cost worldwide by approximately USD\$53.8 billion. Another study estimated that the total health care costs due to physical inactivity in Canadian adults was CAD\$6.8 billion, accounting for 3.3% of the country's total health care costs in 2009 (Janssen, 2012).

Some studies have shown that physical activity has contributed to a decrease in health care costs.

For example, using the Medical Expenditure Panel Survey, a recent study has reported that between 2007 and 2011, physical activity decreased health services utilization and costs for U.S. older adults (Kang & Xiang, 2017). In addition, Sari (2011) showed that exercise and physical activity led to lower utilization of health care services for older adults.

Despite the previously mentioned work, three major gaps in the scientific literature remain. First, most previous studies (Sari, 2011; Yang et al., 2011) have focused on the impact of physical activity on overall health care costs, but little is known regarding the association between sedentary behavior, physical activity, and an individual's out-of-pocket expenditures. Second, few studies (Kang & Xiang, 2017; Rosenberg et al., 2015) have focused on the impact of both sedentary behavior and physical activity on the different components of health care expenditure (i.e., outpatient care, inpatient care, medication, and formal caregiving). Third, research, to date, has focused primarily on Western populations. China is home to the largest older adult population in the world, and to our knowledge, only one study (Zhang & Chaaban, 2013) has investigated the impact of physical inactivity on public health care costs in China. Using data from the Chinese Behavioral Risk Factor Surveillance Surveys and the National Health Service Survey, Zhang and Chaaban (2013) estimated that physical inactivity accounts for 15% of the direct and indirect public health care costs in China.

Health expenditures in China have increased rapidly, partially explained by an increase in the aging population. Based on the National Bureau of Statistics of China, the country's health

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expenditures increased from USD\$82.20 per capita in 2003 to USD \$416 per capita in 2014. Health spending as a percentage of gross domestic product increased from 4.8 to 5.6% (National Health and Family Planning Commission of the People's Republic of China, 2015). In recent years, progress has been made in providing universal health care coverage to Chinese citizens; however, out-of-pocket costs are still substantial. Both inpatient and outpatient care require a variety of deductibles, co-payments, and reimbursement ceilings, as do prescription drugs (Fang, 2017). In 2014, out-of-pocket spending per capita was USD\$367 and USD \$212 in urban and rural areas, respectively, representing about 32% of total health expenditures, with the greatest costs associated with prescription drugs. Across China, reimbursement ceilings are significantly lower for outpatient care than for inpatient care. For example, in 2016, reimbursement ceilings in Beijing were USD\$843 for primary care facilities, USD\$2,809 for outpatient hospital care, and USD\$50,562 for outpatient care in cooperative medical programs.

China is experiencing a rapid demographic and epidemiologic transition. According to the National Bureau of Statistics of China (2015), there are 144 million older adults in China. Although Chinese women live on average 3 years longer than men, sex differences are wider when we consider other factors. Old age in China is marked by cultural factors that affect men and women in different ways, including gender roles, family responsibilities, and income security. These cultural values and opportunities throughout the life course shape people's health and lifestyle. Data from the Chinese Behavioral Risk Factor Surveillance Surveys show that approximately 83.8% of adults in China are considered physically inactive (China Center for Disease Control and Prevention, 2010), with 81.4% and 86.2% of men and women, respectively. As the rapid increase in aging of the population in China continues, the burden of chronic diseases among older adults is expected to rise. Information on the associations of sedentary behavior, physical activity, and different measures of health care expenditure could offer individuals and government policymakers alternative strategies to control health care costs through the control and prevention of chronic diseases.

The purpose of this study was to examine the associations between sedentary behavior, physical activity, and different measures of out-of-pocket health care expenditures among older Chinese adults living in six major cities in China. Our specific objectives were (a) to determine if and where individuals who were more sedentary spent more (out-of-pocket) on health care through outpatient care, inpatient care, medication, and caregiver days; (b) to examine if and where individuals who were more physically active spent less (out-of-pocket) on health care through outpatient care, inpatient care, medication, and formal caregiving; and (c) to assess gender differences between the above associations.

Methods

Participants

This study was based on a cross-sectional survey conducted by Tsinghua University from July to October 2013. The survey was conducted in six major cities in China across three regions: East (Beijing city and Nanjing city, Jiang Su province); Central (Hefei city, Anhui province; and Nanchang city, Jiangxi province); and West (Urumqi city, Xinjiang province; and Chengdu city, Sichuan province). In each province, the capital of the province was selected, and the survey districts were randomly chosen. A survey was conducted by trained interviewers from Tsinghua University who were sent to

each district. Participants were recruited by advertisements in local mass media, and participation was open to all residents in the district. Survey participation was voluntary. Upon signing the consent form, participants were asked to complete a paper-based questionnaire at a community center. A RMB\$20 (USD\$3.28) gift was offered upon completion of the questionnaire as a token of appreciation. Each participant recruited for the study was over 60 years of age. A total of 5,000 questionnaires were distributed—4,800 questionnaires were returned and 4,165 were considered acceptable. Statistical analyses were conducted on a sample of 4,165 responses. The study was approved by the ethical committee of Tsinghua University.

Measures

The questionnaire assessed demographic information (age, gender, weight, height, ethnicity, education level, marital status, and annual household income); lifestyle (smoking and sleeping); health (self-rated health status, chronic conditions, days in hospital, and use of formal caregiver in past year); and sedentary behavior and physical activity. We assessed the participants' sedentary behavior and physical activity level in the past 7 days using the Physical Activity Scale for the Elderly (PASE) questionnaire (Washburn, Smith, Jette, & Janney, 1993). PASE was developed by Washburn to assess the physical activity of older adults in the United States. The PASE questionnaire is a brief, easy to use instrument to assess physical activity levels in older adults (Schuit, Schouten, Westerterp, & Saris, 1997). To ensure validity and reliability, we used the version of the PASE questionnaire adjusted for Chinese older adults' physical activity characteristics (Yu, Zhu, Qiu, & Zhang, 2012). The validity and reliability of the Chinese version of PASE has been published elsewhere (Yu et al., 2012). The PASE uses frequency, duration, and intensity level of activity over the past 7 days to assign a score ranging from 0 to 785, with higher scores indicating greater physical activity level (Washburn et al., 1993). We calculated total PASE score for each survey participant based on their answers to the survey questions.

Total weekly hours of sedentary behavior in the past 7 days were assessed based on the answers to two questions from the PASE assessment tool: (a) "How many days over the past 7 days did you participate in sitting activities such as watching TV, using a computer, reading, or doing handicrafts?" and (b) "On average, how many hours per day did you engage in these sitting activities?" Total weekly hours of sedentary behavior were calculated by multiplying daily average number of hours spent on sitting activities by 7.

Health Care Expenditure Measures

The survey included specific question items on health care expenditure across five outcome variables: annual total health care expenditure; annual out-of-pocket expenditure on outpatient care; inpatient care (i.e., hospitalization); medication; and days receiving formal care by a caregiver.

The question regarding annual total health care cost asked, "What was your total health care cost expenditure in the last year?" The four choices were RMB\$0–RMB\$2,000 (USD\$0–USD\$327); RMB\$2,001–RMB\$10,000 (USD\$328–USD\$1,639); RMB \$10,001–RMB\$19,999 (USD\$1,640–USD\$3,278); and RMB \$20,000 and above (USD\$3,729 and above). The question regarding annual out-of-pocket expenditure on outpatient care read, "What was your out-of-pocket expenditure on outpatient care in the last year?" The four choices were RMB\$0–RMB\$500 (USD \$0–USD\$81); RMB\$501–RMB\$1,000 (USD\$82–USD\$163);

RMB\$1,001–RMB\$4,999 (USD\$164–USD\$819); and RMB \$5,000 and above (USD\$820 and above). The question regarding annual out-of-pocket expenditure on outpatient care on medication was, “What was your out-of-pocket expenditure on medication in the last year?” The four choices were RMB\$0–RMB\$500 (USD \$0–USD\$81); RMB\$501–RMB\$1,000 (USD\$82–USD\$163); RMB\$1,001–RMB\$4,999 (USD\$164–USD\$819); and RMB \$5,000 and above (USD\$820 and above). The question regarding annual out-of-pocket expenditure on inpatient care read “What was your out-of-pocket expenditure on inpatient care in the last year?” The four choices were RMB\$0–RMB\$1,000 (USD\$0–USD\$163); RMB\$1,001–RMB\$5,000 (USD\$164–USD\$819); RMB\$5,001–RMB\$9,999 (USD\$820–USD\$1,638); and RMB\$10,000 and above (USD\$1,639 and above). Finally, the question regarding days receiving health care by a formal caregiver asked, “How many days have you received care by a formal caregiver?” The four choices were 0, 1–10, 11–30, and 30 days above.

Data Analysis

Data analysis was performed to evaluate the associations between health care expenditure, sedentary behavior, and physical activity. Two-sample independent *t* tests were conducted on continuous variables and chi-square tests were conducted on dichotomous and/or categorical variables for the characteristics of participants. We used interval regressions adjusting for age, marital status, annual household income, education level, city, race, body mass index (BMI), smoking status, and self-rated health in the last year. Interval regression was used for model outcomes that have interval

censoring data (Tobin, 1958). We used generalization of censored regression when appropriate to determine the interval each observation of the outcome variable fell into, without knowing the exact value of the observation (UCLA: Statistical Consulting Group, 2017). The estimated coefficient of health care cost can be interpreted as a change in independent variable (i.e., physical activity) with respect to a change in outcome variable (i.e., health care cost). All statistical analyses were conducted using Stata software (version 14; StataCorp LLC, College Station, TX).

Results

Table 1 presents the characteristics of the study participants. Women accounted for 58.6% of the participants. The average age was 69 years. The average BMI was 23.4 kg/m². The average number of chronic diseases was 1.9, with women having more chronic diseases than men. Most of the participants (88%) were of Han ethnicity. Almost half (49.6%) had earned a college degree or above. Most of them (83.6%) were married. Almost 42.3% of participants' annual income fell into the RMB\$10,000–RMB \$40,000 range category, which as of 2013 (year of data collection), converts to approximately USD\$1,639–USD\$6,557. Most participants (79.1%) were current nonsmokers. A majority (93%) reported fair, good, or excellent health.

Table 2 shows the descriptive statistics for all study variables by sex. The average time spent in sedentary behavior among men was 12.32 hr/day, while women were sedentary for fewer minutes, with an average of 12.16 hr/day. The average physical activity PASE score was 118.7. Women did significantly more physical

Table 1 Characteristics of the Study Participants

Variable	Percentage/Mean	Percentage/Mean	Percentage/Mean	<i>p</i> value
	Total	Women	Men	
Sex, <i>N</i> (%)	4,165 (100.0)	2,442 (58.6)	1,723 (41.4)	<.001
Age (years), mean (<i>SD</i> ; 95% CI)	69.20 (7.74; 68.93–69.42)	68.15 (7.77; 67.83–68.45)	70.65 (7.46; 70.29–71.06)	<.001
BMI (kg/m ²), mean (<i>SD</i> ; 95% CI)	23.43 (3.66; 23.32–23.55)	23.47 (3.81; 23.31–23.62)	23.39 (3.44; 23.21–23.56)	.492
No. of chronic conditions, mean (<i>SD</i> ; 95% CI)	1.92 (1.57; 1.88–1.96)	2.01 (1.60; 1.95–2.08)	1.78 (1.53; 1.70–1.85)	<.001
Ethnicity, <i>N</i> (%)				.058
Han	3,666 (88.0)	2,169 (88.8)	1,497 (86.9)	
minority groups	499 (12.0)	273 (11.2)	226 (13.1)	
Education, ≤9 years, <i>N</i> (%) ^a	2,018 (50.4)	1,329 (52.9)	779 (46.9)	
Marital status, <i>N</i> (%)				<.001
married	3,031 (83.6)	1,693 (80.1)	1,338 (88.4)	
widowed	499 (13.8)	357 (16.9)	142 (9.4)	
other	96 (2.6)	63 (1.7)	33 (0.9)	
Annual household income (RMB\$), <i>N</i> (%) ^b				<.001
<10,000	961 (28.9)	578 (28.9)	383 (26.6)	
10,000–40,000	1,402 (42.3)	814 (43.2)	588 (40.8)	
40,001–79,999	713 (21.5)	368 (19.5)	345 (24.0)	
≥80,000	247 (7.4)	123 (6.5)	124 (8.6)	
Current smoker, <i>N</i> (%)	785 (20.9)	108 (4.9)	677 (42.9)	<.001
Self-rated health				.583
fair, good, or excellent health	3,786 (93.0)	2,215 (93.2)	1,571 (92.7)	
poor or very poor health status	285 (7.0)	162 (6.8)	123 (7.3)	
Public health insurance coverage, <i>N</i> (%)	2,482 (88.4)	1,471 (88.4)	1,011 (88.8)	.768

Note. CI = confidence interval; BMI = body mass index.

^aEducation 9 years are high school finish. ^bUSD\$1 = RMB\$6.10 in 2013.

activity on average than men (124.7 vs. 110.2, $p < .001$). There were no significant differences between men and women in out-of-pocket health care expenditures, medication, and inpatient care among survey participants. Women spent on average significantly more of annual total out-of-pocket health care expenditure on outpatient care ($p = .002$) than men. Almost half (44%) of all the participants reported receiving no formal care by a caregiver in the past year, whereas 35%, 14.2%, and 6.8% reported 1–10, 11–30, and over 30 days, respectively.

Table 3 shows the results of interval regression analysis between sedentary behavior and out-of-pocket health care expenditure for the participants. Sedentary behavior was found to be positively associated with annual total out-of-pocket health care expenditure, annual out-of-pocket health care expenditure for outpatient care, medication, inpatient care, and for formal caregiving costs among the survey participants. An increase in sedentary behavior by each hour was associated with a higher annual total out-of-pocket health care expenditure by USD\$41.90 (RMB\$255.56; 95% confidence interval [CI] [RMB\$135.25, RMB\$255.56]); a higher expenditure on outpatient care by USD\$14.16 (RMB\$86.63; 95% CI [RMB\$53.45, RMB\$119.82]); a higher expenditure on medication by USD\$5.33 (RMB\$32.53; 95% CI [RMB\$5.72, RMB\$59.33]); a higher expenditure on

inpatient care by USD\$26.92 (RMB\$164.21; 95% CI [RMB\$81.84, RMB\$246.57]); and an increase use in formal caregiving cost by 0.48 day (95% CI [0.28, 0.68]). Adjusting for covariates (i.e., age, marital status, education level, annual household income, BMI, city living, smoking status, self-rated health, and number of chronic diseases) did not substantially alter the associations of sedentary behavior with out-of-pocket health care expenditure.

Table 4 shows the results of interval regression analysis between physical activity and out-of-pocket health care expenditures among the participants. Physical activity was found to be negatively associated with annual total out-of-pocket health care expenditure, expenditure on outpatient care, medication, inpatient care, and formal caregiving costs among the survey participants. An increase in each physical activity PASE score was associated with a reduction in annual total out-of-pocket health care expenditure by USD\$1.21 (RMB\$7.37; 95% CI [RMB\$ -11.60, RMB\$ -3.13]); a reduction in expenditure on outpatient care by USD\$0.25 (RMB\$1.5; 95% CI [RMB\$ -2.72, RMB\$ -0.41]); a reduction in medication by USD\$0.15 (RMB\$0.94; 95% CI [RMB\$ -1.89, RMB\$0.03]); a reduction in inpatient care by USD\$0.90 (RMB\$ -5.51; 95% CI [RMB\$ -8.43, RMB\$ -2.59]); and a reduction in formal caregiving costs by -0.02 day (95% CI [-0.03, -0.02]).

Table 2 Health Care Expenditure, Sedentary Behavior, and Physical Activity by Sex

	<i>N (%)</i> /Mean (SD; 95% CI)	<i>N (%)</i> /Mean (SD; 95% CI)	<i>N (%)</i> /Mean (SD; 95% CI)	<i>p</i> value
	All	Women	Men	
Sedentary behavior (hr/day)	12.32 (2.79; 12.24–12.41)	12.16 (2.82; 12.05–12.28)	12.54 (2.74; 12.42–12.68)	<.001
Total physical activity PASE	118.75 (78.93; 116.35–121.15)	124.72 (79.01; 121.58–127.86)	110.26 (78.06; 106.57–113.96)	<.001
Total health care expenditure (RMB\$)				.104
<2,000	1,506 (41.2)	858 (23.5)	648 (17.7)	
2,001–10,000	1,642 (40.0)	857 (23.4)	605 (16.5)	
10,001–19,999	456 (12.5)	273 (7.5)	183 (5.0)	
≥20,000	233 (6.4)	152 (4.2)	181 (2.2)	
Expenditure on outpatient care (RMB\$)				.002
<500	1,409 (37.8)	782 (21.0)	627 (16.8)	
501–1,000	1,092 (29.3)	647 (17.4)	445 (11.9)	
1,001–4,999	850 (22.8)	501 (13.4)	349 (9.4)	
≥5,000	377 (10.1)	249 (6.7)	128 (3.4)	
Expenditure on inpatient care (RMB\$)				.325
<1,000	1,807 (56.1)	1,054 (32.7)	763 (23.4)	
1,001–5,000	896 (27.8)	504 (15.6)	392 (12.2)	
5,001–9,999	347 (10.8)	215 (6.7)	132 (4.1)	
≥10,000	171 (5.3)	98 (3.0)	73 (2.3)	
Expenditure on medication (RMB\$)				.517
<500	1,798 (50.5)	1,049 (29.5)	749 (21.1)	
501–1,000	1,044 (29.3)	598 (16.8)	446 (12.5)	
1,001–4,999	572 (16.1)	349 (9.8)	223 (6.3)	
≥5,000	144 (16.0)	82 (2.3)	62 (1.7)	
Caregiver days				.375
0	1,582 (44.0)	934 (44.5)	648 (43.2)	
1–10	1,259 (35.0)	716 (34.1)	543 (36.3)	
11–30	509 (14.2)	305 (14.5)	204 (13.6)	
>30	246 (6.8)	143 (6.8)	103 (6.8)	

Note. CI = confidence interval; PASE = Physical Activity Scale for the Elderly.

Table 3 Estimated Relationships of Sedentary Behavior and Annual Out-of-Pocket Health Care Expenditure by Sex

	Total				Female				Male			
	Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted	
	Coefficient (95% CI)	N	Coefficient (95% CI)	N	Coefficient (95% CI)	N	Coefficient (95% CI)	N	Coefficient (95% CI)	N	Coefficient (95% CI)	N
Total health care expenditure (RMB\$)												
SB	255.60*** (135.25 to 375.94)	3,487	214.46*** (82.68 to 346.25)	2,722	230.49** (72.00 to 388.98)	2,028	208.76* (33.03 to 384.50)	1,516	319.23*** (133.41 to 505.05)	1,459	279.75** (79.19 to 480.32)	1,206
Outpatient health care expenditure (RMB\$)												
SB	86.63*** (53.45 to 119.82)	3,556	70.28*** (34.39 to 106.17)	2,765	95.63*** (51.38 to 139.88)	2,064	100.74*** (51.81 to 149.68)	1,539	86.81*** (36.66 to 136.97)	1,492	58.86* (6.67 to 111.05)	1,226
Medication health care expenditure (RMB\$)												
SB	32.53* (5.72 to 59.33)	3,042	27.52 (-3.61 to 58.66)	2,636	22.57 (-11.95 to 57.09)	1,974	10.41 (-30.26 to 51.07)	1,461	49.08* (6.24 to 91.93)		50.64* (1.85 to 99.44)	1,175
Inpatient health care expenditure (RMB\$)												
SB	164.21*** (81.84 to 246.57)	3,074	112.38* (20.99,203.76)	2,374	190.17*** (82.18 to 298.17)	1,777	126.35* (7.01 to 235.69)	1,307	130.48* (2.20 to 258.75)	1,297	116.34 (-26.92 to 259.60)	1,067
Caregiver (day)												
SB	0.55*** (0.31 to 0.80)	3,437	0.45*** (0.18 to 0.72)	2,661	0.60*** (0.28 to 0.92)	1,991	0.41* (0.05 to 0.79)	1,478	0.49** (0.12 to 0.88)	1,446	0.50* (0.08 to 0.91)	1,183

Note. CI = confidence interval; SB = sedentary behavior. USD\$1 = RMB\$6.10 in 2013. Interval regressions were performed to estimate the associations between sedentary behavior, physical activity, and annual out-of-pocket health care expenditures, adjusting for age, marital status, education level, annual household income, body mass index, city living, smoking status, self-rated health, and number of chronic diseases.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4 Estimated Relationships of Physical Activity and Annual Out-of-Pocket Health Care Expenditure by Sex

	Total				Female				Male			
	Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted	
	Coefficient (95% CI)	N	Coefficient (95% CI)	N	Coefficient (95% CI)	N	Coefficient (95% CI)	N	Coefficient (95% CI)	N	Coefficient (95% CI)	N
Total health care expenditure (RMB\$)												
PA	-7.37*** (-11.61 to -3.13)	3,653	-4.57 (-9.14 to -0.01)	2,480	-9.14** (-14.80 to -3.49)	2,140	-7.83* (-13.99 to -1.67)	1,593	-6.07 (-12.49 to 0.35)	1,513	-2.85 (-9.72 to 4.03)	1,246
Outpatient health care expenditure (RMB\$)												
PA	-1.57** (-2.73 to -0.41)	3,725	-0.63 (-1.86 to 0.61)	2,885	-1.84* (-3.38 to -0.30)	2,178	-1.58 (-3.25 to 0.10)	1,619	-1.74 (-3.52 to 0.02)	1,547	-0.52 (-2.34 to 1.32)	1,266
Medication health care expenditure (RMB\$)												
PA	-0.94 (-1.89 to 0.00)	3,555	-0.67 (-1.75 to 0.42)	2,741	-0.32 (-1.55 to 0.90)	2,078	-0.20 (-1.62 to 1.21)	1,531	-1.90* (-3.40 to -0.40)	1,477	-1.36 (-3.07 to 0.35)	1,210
Inpatient health care expenditure (RMB\$)												
PA	-5.51*** (-8.43 to -2.60)	3,220	-3.84* (-7.07 to -0.62)	2,480	-6.40*** (-10.29 to -2.51)	1,871	-5.16* (-9.47 to -0.85)	1,373	-4.42 (-8.87 to 0.03)	1,349	-3.25 (-8.20 to 1.68)	1,107
Caregiver (day)												
PA	-0.03*** (-0.04 to -0.02)	3,593	-0.02*** (-0.03 to -0.01)	2,771	-0.03*** (-0.05 to -0.02)	2,097	-0.03*** (-0.04 to -0.02)	1,552	-0.02** (-0.03 to -0.01)	1,496	-0.02* (-0.03 to 0.00)	1,219

Note. CI = confidence interval; PA = physical activity. USD\$1 = RMB\$6.10 in 2013. Interval regressions were performed to estimate the associations between sedentary behavior, physical activity, and annual out-of-pocket health care expenditures, adjusting for age, marital status, education level, annual household income, body mass index, city living, smoking status, self-rated health, and number of chronic diseases.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4 also provides the results for interval regression analyses between physical activity and health care expenditure by sex. Among women, an increase in each physical activity PASE score was associated with a reduction in annual total out-of-pocket health care expenditure by RMB\$9.14 (USD\$1.50; 95% CI [RMB \$ -14.08, RMB\$ -3.49]); a reduction in annual total out-of-pocket health care expenditure on outpatient care by RMB\$1.84 (USD \$0.30; 95% CI [RMB\$ -3.38, RMB\$ -0.30]); and a reduction in inpatient care by RMB\$6.40 (USD\$1.05; 95% CI [RMB\$ -10.29, RMB\$ -2.51]). In contrast, none of the associations between physical activity and health care expenditures were statistically significant among men ($p < .05$; p values $\geq .05$). However, physical activity was significantly negatively related to formal caregiving costs among men. Adjusting for covariates (i.e., age, marital status, education level, annual household income, BMI, city living, smoking status, self-rated health, and number of chronic diseases) did not substantially alter the associations of physical activity with out-of-pocket health care expenditure between different sexes.

Discussion

This study examined the association between sedentary behavior, physical activity, and out-of-pocket health care expenditures among Chinese older adults. Our results provide important new evidence on the association between sedentary behavior, physical activity, and out-of-pocket health care expenditure for older adults in China. In China, rising health care costs associated with the growing older adult population represent a significant public health and fiscal challenge for the nation. Our research provides new insight into the relationships between lifestyle behaviors and health care costs for older adults living in six urban locations across China. Although it is unclear whether our findings can be generalized to all of China, the cities included in our study were geographically dispersed across the nation and are broadly representative of metropolitan China.

Our findings suggest that sedentary behavior is common among Chinese older adults and is associated with greater out-of-pocket health care expenditure, including outpatient care, medication, inpatient care, and formal caregiving costs. Consistent with previous research (Peeters, Mishra, Dobson, & Brown, 2014; Rosenberg et al., 2015), sedentary behavior contributed significantly to the out-of-pocket health care expenditures among participants in our study. In our study, a 1 hr increase in sedentary behavior was associated with a USD\$35 (RMB\$214) increase in total annual adjusted health care expenditures. Based on a retrospective cross-sectional study in the United States, an increase by 1 hr each day of sedentary behavior contributed to an increase in total annual adjusted health care costs of USD\$126 for U.S. older adults each year (Rosenberg et al., 2015). Peeters et al. (2014) reported that compared with participants with low sitting time, the total adjusted annual health care cost was AU\$38 higher for participants with high sitting time in Australia in 2010.

Our findings indicate that the relationship between sedentary behavior and health care expenditure was gender specific. Our results showed higher health care expenditures (i.e., total care and medication care) attributed to more time spent in sedentary behavior among men than women, but not in outpatient and inpatient health care expenditures. A possible explanation for this finding is that sedentary behavior is associated with different aspects of health care expenditure for men and women. A previous study also found gender differences in need for psychological health services (Mazzeo et al., 1998). Similarly, Bertakis, Azari, Helms, Callahan, and Robbins (2000) reported gender differences in the

utilization of health care services. Women tended to have lower health status with a higher mean number of visits to their primary care clinic and diagnostic services than men.

Physical activity was associated with a decline in health care expenditures, which is in agreement with previous research (Carlson, Fulton, Pratt, Yang, & Adams, 2015; Cowper et al., 2017; Humphreys, McLeod, & Ruseski, 2014; Martin, Powell, Peel, Zhu, & Allman, 2006; Nguyen et al., 2007; Sari, 2010; Turi, Monteiro, Fernandes, & Codogno, 2016). The current results show that each individual PASE score was associated with a USD\$1 (RMB\$7) reduction in total health care expenditures. A study in the United States reported that sedentary normal-weight adults had \$1,456 more total health care costs than moderately active normal-weight retirees. The study also found that very active retirees had \$1,823 lower total health care costs than their moderately active counterparts (Wang, McDonald, Reffitt, & Edington, 2005). Yang et al. (2011) found that Japanese older adults who increased physical activity levels decreased their annual health care costs by USD\$125 per month. These findings are consistent with our study which found that physical activity was associated with decreasing outpatient health care costs, inpatient health care costs, and decreased formal caregiving costs. Based on the data from the U.S. medical expenditure survey from 2007 to 2011, Kang and Xiang (2017) reported that active adults spent USD\$351 less for inpatient visit health care costs and USD\$52 less for home health care costs compared with physically inactive adults. The present study expands previous findings by focusing on different measures of health care expenditure (i.e., outpatient care, inpatient care, medication, and caregiver days).

Analysis by sex indicated a weaker relationship between health care expenditures and physical activity among men than women. From the cultural point of view, this could be explained by the Chinese traditional gender roles in which women tend to do more physical activity related to daily household chores, taking care of grandchildren, grocery shopping, and so on (Yu, An, & Andrade, 2017). Another possible explanation for this finding is that older women tend to use more health care services compared with older men (Keene & Li, 2005; Redondo-Sendino, Guallar-Castillon, Banegas, & Rodriguez-Artalejo, 2006). Furthermore, a report comparing Chinese men to women found that the total health care expenditure associated with obesity was 31% higher for women (An, 2015). However, the findings on the gender differences for physical activity and health care expenditure are somewhat preliminary and warrant replication in future research.

Sedentary behavior imposes a substantial economic burden on health care systems around the world. Using data from the Chinese Behavioral Risk Factor Surveillance Surveys, Zhang and Chaaban (2013) reported that sedentary behavior was responsible for 15% of all health care expenditure in China. Sedentary behavior not only accounts for substantial economic burden in China (Zhang & Chaaban, 2013), but it is also a major economic burden worldwide (Ding et al., 2016). For example, Pratt et al. (2014) found that physical inactivity was responsible for 1.0–2.6% of total health care expenditure in 11 studies of different health care systems around the world. Evidence of the economic burden of sedentary behavior has been found in Australia (3.7% of total health burden) (Janssen, 2012) and the United Kingdom (1.5% of total direct costs) (Allender, Foster, Scarborough, & Rayner, 2007).

Physical activity is associated with a decrease in chronic diseases such as stroke, Alzheimer's disease, cancer, diabetes, arthritis, hypertension, and cardiovascular diseases (Chodzko-Zajko et al., 2009). Moreover, the older population is more likely to have chronic diseases, and the health care cost for them is

projected to increase the economic burden of physical inactivity in Canada (Katzmarzyk & Janssen, 2004). Chronic diseases place a substantial burden on the health care system in China (Jiang, Yang, & Sanchez-Barricarte, 2016). Therefore, promoting physical activity is an effective way to decrease health care expenditures in older adults. Effective strategies and policy interventions are warranted to reduce the chronic disease burden among the rapidly expanding global population of older adults.

Although this study offers new evidence about the relationship between sedentary behavior, physical activity, and health expenditure for Chinese older adults, there are some limitations worth noting that point to directions for future research. This study was conducted using a self-report questionnaire-based survey and is subject to recall error or bias (Althubaiti, 2016), so caution is warranted when generalizing our outcomes to other countries and communities. Participants tend to report more physical activity and less sedentary behavior (Dyrstad, Hansen, Holme, & Anderssen, 2014).

There are limitations associated with the selection of the PASE questionnaire for the assessment of physical activity participation. While information is available regarding the frequency of physical activity, the precision of the instrument is very limited with respect to duration and intensity. However, these limitations must be balanced with our need to select a robust and easily administered instrument that has been used extensively in the physical activity epidemiology literature and that has been previously validated in the Chinese population.

Future research should use more objective methods to estimate physical activity and sedentary behavior (e.g., accelerometers). The reporting of health care expenditure was in crude categories, which increased the measurement error; however, we used the interval regression analysis method to decrease this bias. Also, the cross-sectional nature of the study can only report associations between sedentary behavior, physical activity, and health care expenditure but cannot infer causations. Inverse causality is a concern of this study since older adults who have been hospitalized in the past year were more likely to have reduced their physical activity levels and increased their sedentary time. Furthermore, data were collected in community centers, meaning that older adults had to travel to the community center to participate in the study. This implies that participants with physical limitations and those most frail were less likely to participate. Finally, the sex differences observed in the present study should be considered preliminary and warrant replication in future research. Although these limitations are important to keep in mind, we believe that our study provides important new insight into relationships among sedentary behaviors, physical activity, and health care costs among a large sample of older adults selected from multiple regions across China.

Conclusions

This study offers the evidence of the associations between sedentary behavior, physical activity, and out-of-pocket health care expenditures among Chinese older adults. Moreover, this study provides suggestions for future research into this important but understudied topic. Although effects of physical activity tended to be more important for older women than for older men, public health policy should focus on promoting physical activity and decreasing sedentary behavior in both women and men. Effective population-level policy interventions are needed to reduce sedentary behavior and to increase physical activity among China's rapidly growing older population.

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