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SSM - Population Health 25 (2024) 101643

Contents lists available at ScienceDirect

SSM - Population Health

journal homepage: www.elsevier.com/locate/ssmph

The impact of physical activity on household out-of-pocket medical expenditure among adults aged 45 and over in urban China: The mediating role of spousal health behaviour

Xiaodong Zhang [a,b,1], Yanan Zhang [b,1], Bin Guo [a,c,1], Gong Chen [a], Rui Zhang [c], Qi Jing [d,b], Hafiz T.A. Khan [e,b], Lei Zhang [a,*]

[a] Institute of Population Research, Peking University, Beijing, 100871, China
[b] The Oxford Institute of Population Ageing, University of Oxford, OX2 6PR, United Kingdom
[c] National Sports Industry Research Base, Peking University, Beijing, 100871, China
[d] School of Management, Shandong Second Medical University, Weifang, 261053, China
[e] College of Nursing, Midwifery and Healthcare, University of West London, TW8 9GB, United Kingdom

ARTICLE INFO

Keywords:
Physical activity
Medical expenditure
Spousal physical activity
China

ABSTRACT

Background: Increasing medical expenditure is viewed as one of the critical challenges in the context of population ageing. Physical activity (PA), as a primary prevention strategy for promoting health, is considered as an effective way to curb the excessive growth in medical expenditure. This study aimed to analyze the association between PA and the household out-of-pocket medical expenditure (HOPME) among Chinese urban adults aged 45 and over, and to explore the mediating role of spousal health behaviour.

Methods: This study analyzed a nationally longitudinal survey: 2014–2018 China Family Panel Studies (CFPS). Fixed effects regression model was applied to estimate the association between PA and annual HOPME. Sobel model was utilized to test the mediating effect.

Results: (1) PA was negatively associated with the annual HOPME among urban resident aged 45 and over in China. Exercising 1–5 times per week and maintaining the duration of each exercise session at 31–60 min were effective in reducing annual HOPME. (2) Spousal PA played a significant mediating role in the relationship between respondent's PA and annual HOPME. (3) The negative association between the respondent's PA and HOPME were found among women and those aged between 45 and 65, so was the mediating effect of spouse's PA.

Conclusion: Individual PA not only directly reduces HOPME but also indirectly contributes to this reduction by enhancing the PA levels of their spouses. To capitalize on these benefits, more actions should be taken to increase the availability of PA facilities, enhance the public awareness of PA's benefits, and encourage residents to consistently engage in regular PA.

1. Introduction

Over the recent decades, China has faced a significant increase in medical expenditures, which is partially linked to the growing demand for healthcare services triggered by the rapid population aging. From 2013 to 2022, the total (nominal) health expenditure witnessed a remarkable rise from 3166.89 billion CNY to 8532.75 billion CNY, reflecting an average annual growth rate of 16.94%. Meanwhile, the (nominal) per capital medical expenditure increased from 2316.23 CNY to 6044.09 CNY, with an annual growth rate of 16.09% (National Bureau of Statistics, 2023). The increasing medical costs represent a multifaceted challenge, straining household finances, amplifying societal inequities, and placing considerable pressure on national healthcare system (Ding et al., 2022; Tang et al., 2022; X. Wang & Feng, 2022).

Physical activity (PA) is globally recognized as an accessible and equitable strategy for enhancing health and well-being (Durstine et al.,

* Corresponding author.
E-mail addresses: zhangxiaodong0625@163.com (X. Zhang), yanan.zhang@ageing.ox.ac.uk (Y. Zhang), botegb@126.com (B. Guo), chengong@pku.edu.cn (G. Chen), zhrui@pku.edu.cn (R. Zhang), jingq@wfmc.edu.cn (Q. Jing), hafiz.khan@ageing.ox.ac.uk (H.T.A. Khan), zhang.lei@pku.edu.cn (L. Zhang).
[1] These three authors equally contributed to this work.

https://doi.org/10.1016/j.ssmph.2024.101643
Received 15 January 2024; Received in revised form 17 February 2024; Accepted 21 February 2024
Available online 28 February 2024

2013), crucial for managing the healthcare demands of an aging population (Guo et al., 2016; Shephard, 1985). The Chinese government, since 2016, has embarked on an ambitious public health initiative with the 'Healthy China 2030 Strategy' and the 'National Strategy for Actively Addressing Population Ageing'. Integral to these policies is the promotion of a national fitness campaign aimed at increasing physical activity among the populace. These initiatives target the reduction of chronic disease prevalence through sustained physical engagement, thereby aiming to reduce the demand for healthcare services and associated costs.

Extensive research has confirmed that PA played a crucial role in improving both physiological and psychological health among older adults (Callow et al., 2020; Guo et al., 2016; Mitchell, 2013). It can significantly reduce the risk of chronic diseases such as hypertension, obesity, diabetes, and cardiovascular conditions (Cunningham et al., 2020; Durstine et al., 2013; Rhodes et al., 2017), which are predominant among middle-aged and older adults. Several studies highlighted the significant reduction in medical expenditures associated with chronic diseases when older adults engaged in regular PA (Tsuji et al., 2003; F. F. Wang et al., 2005; Wu et al., 2019). Specifically, Wu et al. (2019) reported that PA (at least 5 times per week for more than 30 min each session) could notably decrease medical expenditure for middle-aged and older individuals with diabetes (Wu et al., 2019). Moreover, the relationship between PA prevalence and healthcare expenditure has been observed at a macro level as well. Sato et al. (2020) conducted a longitudinal study in the United States, revealing that a 10% increase in PA prevalence at the state level could lead to a reduction in residents' medical expenditure by 0.4% after two years and by 1.0% after three years (Sato et al., 2020), indicating the broader economic benefits of PA.

Despite the abundance of evidence underscoring the health benefits of PA, a significant proportion of adults in China do not meet the recommended levels of physical activity (Chatterji et al., 2008; Liu et al., 2018). Against this backdrop, numerous studies investigated the factors that may encourage PA among the general population to enhance public health (Chen et al., 2022; Schrempft et al., 2019; Spiteri et al., 2019). Among these determinants, spousal behaviour has been recognized as a pivotal influence. Spouses often exhibit comparable patterns in health-seeking behaviours and engage in similar health risk activities (Meyler et al., 2007). This homogeneity in behaviour can be partially attributed to assortative mating, where individuals tend to select partners with comparable traits. Beyond initial partner selection, spousal behaviours may converge over time due to a shared living environment, which fosters behavioural concordance (Cobb et al., 2016). More importantly, one spouse's behaviour may influence and modify the other's behaviour, or there may be a mutual and simultaneous influence between spouses, leading their behaviours to align over time (Molloy et al., 2009; Robards et al., 2012). Spousal influences are expected to increase in significance post-retirement, when couples typically spend more time in each other's company and their social networks contract with the reduction in work-related connections (Van Solinge & Henkens, 2005).

Research has demonstrated that changes in an individual's PA levels are often influenced by their spouse's activity patterns (Cobb et al., 2016; Harada et al., 2018; Wilson, 2002). A cross-sectional investigation from California suggested leisure-time physical activity (LTPA) of spouse was significantly related to LTPA of participant among married couples (Satariano et al., 2002). Pettee et al. (2006) examined the association between PA level of husband and their spouses, and found that spousal PA was a significant determinant for PA participation among older adults. Similarly, Jurj et al. (2006) found women were more likely to exercise regularly if their husband kept the same health behaviour.

Presently, the extent to which an individual's engagement in PA influences their spouse's PA levels and subsequently enhances the overall health status of the household, thereby reducing medical expenditures, remains an area requiring further clarification in current research. This knowledge has the potential to inform cost-effective public health strategies aimed at promoting the public health, and reducing medical expenditure. This is vital given the increasing healthcare costs that pose a significant challenge to households, particularly those with limited access to resources.

To bridge the identified research gap, we utilized data from the 2014–2018 waves of the China Family Panel Study (CFPS), a national longitudinal survey. Our analysis aimed to analyze the mediating effect of a spouse's PA on the association between an individual's PA and the household's medical expenditure among urban residents aged 45 years and older. This study contributed to the literature as follows. First, we investigated the association between individual PA and HOPME to determine whether individual PA can have a 'HOPME reduction effect' at household level. Moreover, this study examined the relationship between the level of individual PA and spousal PA, and then examined the mediating role of spousal PA in the relationship between PA and HOPME.

2. Methods

2.1. Data source

The data for this study was retrieved from the 2014–2018 China Family Panel Studies (CFPS), a comprehensive survey designed to capture the evolving dynamics of Chinese families. The CFPS explored a wide range of topics including physical activities, social security, health care costs, health status, household economics, and family structure. Renowned for being one of the most representative large-scale social surveys in mainland China, the CFPS encompassed 25 provinces, municipalities, and autonomous regions. CFPS employed a sophisticated sampling approach combining multi-stage, implicit stratification with a proportional-to-population size (PPS) method, integrating data from both urban and rural areas for a comprehensive view.

Fig. 1 illustrated the sample selection process of this study. Our aim was to examine the relationship between PA and HOPME among urban residents aged 45 and older.[2] To this end, participants under 45 at the first wave were excluded (n = 9167), as were those living in rural areas (n = 9238). Additionally, we removed the samples with functional limitations, extreme values of household income and medical expenditure,[3] as well as those with missing values of key variables (n = 598). After these adjustments and processing the data into a balanced format, the final sample size used in the study was 4641.

2.2. Variable measurement

2.2.1. Dependent variable

The primary outcome variable in this study was the annual household out-of-pocket medical expenditure (HOPME). We utilized the question: 'Excluding expenditure that have been or are expected to be reimbursed, how much did your family pay directly for medical care in the past 12 months (including the amounts loaned or paid by relatives and friends)?', to measure the annual HOPME of middle-aged and older adults. In the process of data analysis, HOPME were deflated based on 2014 year and we reported the real value of logarithm.

[2] Our study aims to investigate efficient health interventions, particularly physical activity (PA), aimed at promoting health status among middle-aged and older individuals to facilitate healthy ageing. According to the World Health Organization (WHO), individuals aged between 45 and 55 are categorized as the middle-aged group, those between 56 and 65 are considered younger older adults, and individuals aged 66 and over are classified as the older aged group. Therefore, our sample is restricted to those aged 45 and over.

[3] In order to eliminate the effect of extreme values, we winsorized household income and medical expenditure (0.5%).

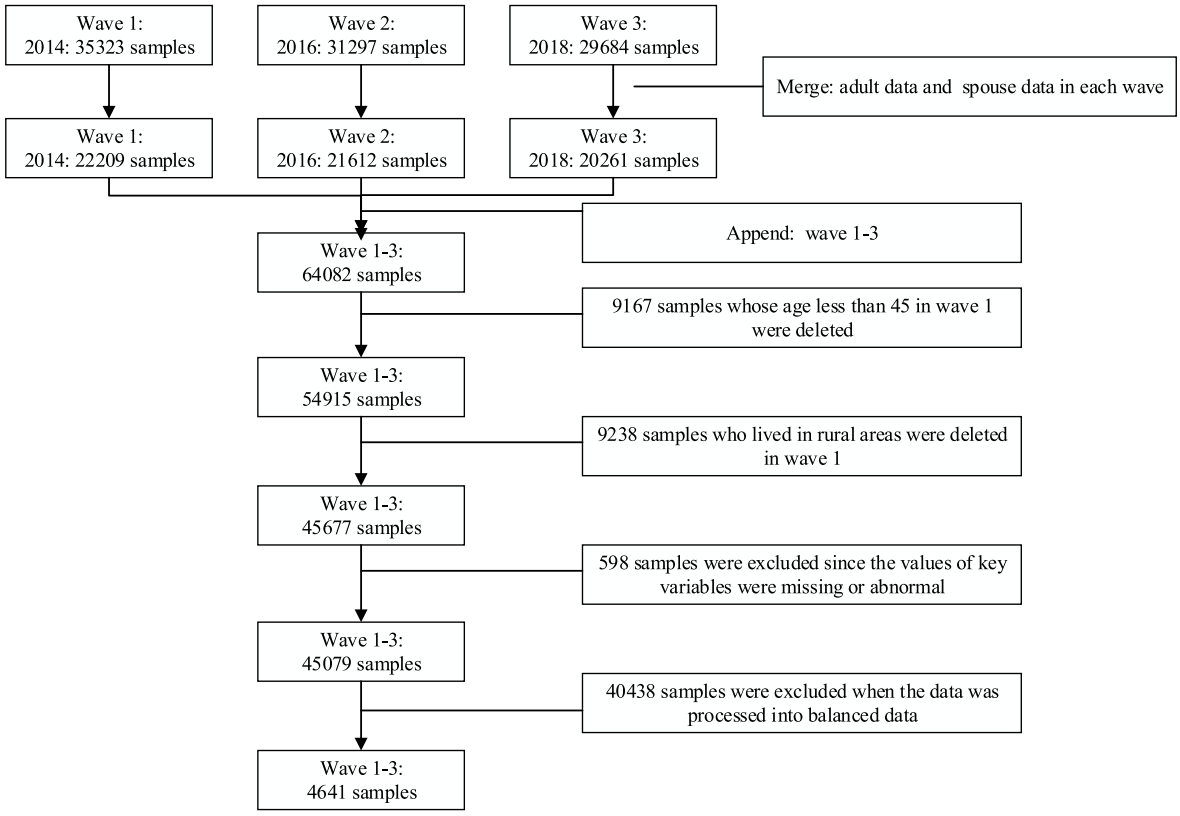

Fig. 1. Flow chart of sample selection.

2.2.2. Independent variable

Based on the questionnaire design of CFPS, we chose three indicators, PA behaviour, the frequency and duration of PA, to measure the PA participations of the middle-aged and older adults. First, to evaluate PA behaviour, participants were asked, 'Did you participate in physical exercise in the past week?'. Responses were quantified, assigning a value of '1' to those who answered 'yes', and '0' to those who did not. Subsequently, the frequency of PA was measured through the question, 'How many times did you engage in physical activity last week?' The responses were categorized into four levels: 'Never', '1–2 times per week', '3–5 times per week', and '6 times or more per week', with corresponding values assigned from '0' to '3' respectively. Lastly, the duration of PA was assessed using the question, 'How long was each exercise session in the past week?'. The responses were classified into four categories: '0–30 min', '31–60 min', '61–90 min', and '90 min or more', with values from '0' to '3' assigned respectively.

2.2.3. Covariates

To mitigate potential biases arising from missing variables, our empirical analysis accounted for several key indicators of respondents and their spouses, which could influence household medical expenditure level (Bai et al., 2012; Carlson et al., 2015; F. F. Wang et al., 2005). These included: 1) Demographic information such as gender and age; 2) Human capital, including educational attainment, self-rated health status, depression, and chronic diseases; 3) Life-style habits such as frequency of drinking and smoking; 4) Socio-economic indicators, including participation in medical insurance schemes, pensions, household income, and working status. Detailed definitions of controlled variables were presented in Table 1.

2.3. Statistical analysis

The analysis involved comparing demographic characteristics and other variables of the sample across years to discern any significant changes or trends. Subsequently, a fixed effects regression model was utilized to investigate the relationship between PA and annual HOPME, which controlled for unobserved variables that were constant over time but vary across individuals. Finally, Sobel model were used to examine the medicating role of spousal PA in the relationship between PA and HOPME. All analyses were conducted with STATA 16.0.

3. Results

3.1. Descriptive results

Table 1 showed the definitions and descriptive statistics of all variables employed in this study. Between 2014 and 2018, the data revealed a pronounced increase in real annual HOPME, escalating from 5939.66 CNY to 9190.35 CNY. Concurrently, PA participation among the sample also saw a significant upsurge, growing from 60.83% in 2014 to 70.14% in 2018. The majority of these participants engaged in PA for a duration of 0–30 min per session, and the proportion within this range decreased from 47.71% to 39.82% throughout the study period. Meanwhile, the percentage of individuals reporting poor health rose from 17.45% to 20.94%, and those suffering from chronic diseases increased from 29.54% to 31.29%. Inversely, there was a notable decrease in the incidence of depressive symptoms, which declined from 20.10% to 18.94%.

The proportions of drinking and smoking decreased from 17.71% to 16.03% and from 29.41% to 27.02%, respectively. A substantial majority, over 90%, were covered by medical insurance programs. Additionally, there was an increase in the percentage of respondents with pension insurance schemes, rising from 87.72% to 89.85%. Concurrently, as the age of the respondents increased, active participation in the labor market showed a slight decrease, from 32.90% to 30.58%. However, household income demonstrated stable growth over the study period, with the average real income escalating from 84,582.19 CNY to 133,173.4 CNY. The trends observed in spouses' data mirrored those among respondents.

Table 1
Definition and descriptive results of main variables.

Variables	Definitions	2014	2016	2018
		Frequency (%)	Frequency (%)	Frequency (%)
PA	No = 0	606 (39.17)	534 (34.52)	462 (29.86)
	Yes = 1	941 (60.83)	1013 (65.48)	1085 (70.14)
Frequency of PA	Never = 0	606 (39.17)	534 (34.52)	462 (29.86)
	1-2 times per week = 1	105 (6.79)	94 (6.08)	95 (6.14)
	3-5 times per week = 2	211 (13.64)	186 (12.02)	216 (13.96)
	6 times and above per week = 3	625 (40.40)	733 (47.38)	774 (50.03)
Duration of PA	0–30 min = 0	738 (47.71)	688 (44.47)	616 (39.82)
	31–60 min = 1	422 (27.28)	410 (26.50)	483 (31.22)
	61–90 min = 2	104 (6.72)	115 (7.43)	138 (8.92)
	>90 min = 3	283 (18.29)	334 (21.59)	310 (20.04)
Gender	Female = 0	699 (45.18)	699 (45.18)	699 (45.18)
	Male = 1	848 (54.82)	848 (54.82)	848 (54.82)
Self-rated health	Excellent = 1	106 (6.85)	89 (5.75)	82 (5.30)
	Very good = 2	208 (13.45)	148 (9.57)	132 (8.53)
	Good = 3	644 (41.63)	616 (39.82)	666 (43.05)
	Fair = 4	319 (20.62)	403 (26.05)	343 (22.17)
	Poor = 5	270 (17.45)	291 (18.81)	324 (20.94)
Depressive symptom	No = 0	1236 (79.90)	1274 (82.35)	1254 (81.06)
	Yes = 1	311 (20.10)	273 (17.65)	293 (18.94)
Chronic disease	No = 0	1090 (70.46)	1102 (71.23)	1063 (68.71)
	Yes = 1	457 (29.54)	445 (28.77)	484 (31.29)
Drinking	No = 0	1273 (82.29)	1283 (82.93)	1299 (84.92)
	Yes = 1	274 (17.71)	264 (17.07)	248 (16.03)
Smoking	No = 0	1092 (70.59)	1121 (72.46)	1129 (72.98)
	Yes = 1	455 (29.41)	426 (27.54)	418 (27.02)
Pension	No = 0	190 (12.28)	188 (12.15)	157 (10.15)
	Yes = 1	1357 (87.72)	1359 (87.85)	1390 (89.85)
Medical insurance	No = 1	111 (7.18)	129 (8.34)	109 (7.05)
	Yes = 1	1436 (92.82)	1418 (91.66)	1438 (92.95)
Working status	No = 0	1038 (67.10)	1038 (67.10)	1074 (69.42)
	Yes = 1	509 (32.90)	509 (32.90)	473 (30.58)
Spouse PA	No = 0	673 (43.50)	572 (36.97)	500 (32.32)
	Yes = 1	874 (56.50)	975 (63.03)	1047 (67.68)
Frequency of spouse PA	Never = 0	673 (43.50)	572 (36.97)	500 (32.32)
	1-2 times per week = 1	111 (7.18)	105 (6.79)	121 (7.82)
	3-5 times per week = 2	210 (13.57)	191 (12.35)	218 (14.09)
	6 times and above per week = 3	553 (35.75)	679 (43.89)	708 (45.77)
Duration of spouse PA	0–30 min = 0	796 (51.45)	717 (46.35)	641 (41.43)
	31–60 min = 1	405 (26.18)	406 (26.24)	455 (29.41)
	61–90 min = 2	91 (5.88)	104 (6.72)	139 (8.99)
	>90 min = 3	255 (16.48)	320 (20.68)	312 (20.17)
Self-rated health	Excellent = 1	130 (8.40)	106 (6.85)	114 (7.37)
	Very good = 2	221 (14.29)	154 (9.95)	131 (8.47)
	Good = 3	645 (41.69)	613 (39.63)	684 (44.21)
	Fair = 4	288 (18.62)	388 (25.08)	308 (19.91)
	Poor = 5	263 (17.00)	286 (18.49)	310 (20.04)
Depressive symptom	No = 0	1222 (78.99)	1251 (80.87)	1212 (78.35)
	Yes = 1	325 (21.01)	296 (19.13)	335 (21.65)
Chronic disease	No = 0	1099 (71.04)	1130 (73.04)	1090 (70.46)
	Yes = 1	448 (28.96)	417 (26.96)	457 (29.54)
Drinking	No = 0	1291 (83.45)	1306 (84.42)	1309 (84.62)
	Yes = 1	256 (16.55)	241 (15.58)	238 (15.38)
Smoking	No = 0	1167 (75.44)	1172 (75.76)	1184 (76.54)
	Yes = 1	380 (24.56)	375 (24.24)	363 (23.46)
Pension	No = 0	218 (14.09)	216 (13.96)	184 (11.89)
	Yes = 1	1329 (85.91)	1331 (86.04)	1363 (88.11)
Medical insurance	No = 1	89 (5.75)	129 (8.34)	109 (7.05)
	Yes = 1	1458 (94.25)	1418 (91.66)	1438 (92.95)
Working status	No = 0	978 (63.22)	960 (62.06)	1013 (65.48)
	Yes = 1	569 (36.78)	587 (37.94)	534 (34.52)
		Mean (SE)	**Mean (SE)**	**Mean (SE)**
Annual household income	CNY	10.95 (0.89)	11.21 (0.81)	11.52 (0.76)
Annual HOPME	CNY	7.84 (1.30)	8.04 (1.34)	8.30 (1.28)
Age	years	58.82 (8.59)	60.86 (8.58)	62.82 (8.58)
Family size	Number of family member	3.64 (1.57)	3.61 (1.63)	3.53 (1.67)
Years of education	years	8.60 (4.57)	8.25 (4.61)	8.31 (4.55)
Age of spouse	years	55.77 (12.07)	57.96 (12.00)	59.43 (12.43)
Years of spouse education	years	8.69 (4.69)	8.32 (4.72)	8.46 (4.70)

Note: 1) For categorical variables, frequency and percent were reported; for continuous variables, means and standard error (S.E) were reported; 2) between 2014 and 2018, the nominal values of annual household income were 84582.19 CNY, 110889.4 CNY and 133173.4 CNY, respectively, and the original values of HOPME were 5939.66 CNY, 8393.61 CNY and 9190.35 CNY. Household income and HOPME were deflated based on 2014 year.

3.2. Multivariate analysis

Table 2 presented the fixed-effects model estimates examining the association between PA and annual HOPME among urban residents aged 45 and over in China.[4] The results in Column 1 revealed that those participated in PA was associated with a 10.2% reduction in annual HOPME ($\beta = -0.102$, 95% CI: −0.201, −0.002), compared to counterparts who did not engage in PA. Furthermore, Column 2 indicated that engaging in PA 1–2 times and 3–5 times per week were negatively associated with annual HOPME ($\beta = -0.198$, 95% CI: −0.376, −0.019; $\beta = -0.178$, 95% CI: −0.318, −0.038). Meanwhile, engaging in PA 6 times and above per week had no effect on HOPME ($\beta = -0.056$, 95% CI: −0.164, 0.051). Column 3 showed that compare those who exercised less than 30 min (0–30 min), participants who exercised for a duration of 31–60 min each session ($\beta = -0.111$, 95% CI: −0.216, −0.006) experienced an 11.1% lower annual HOPME. However, there is no statistically significant association between PA and HOPME among those people who exercised over 60 min ($\beta = -0.086$, 95% CI: −0.249, 0.076; $\beta = -0.050$, 95% CI: −0.173, 0.073).

In terms of controlled variables, increasing age and poor self-rated health level were positively associated with annual HOPME. Conversely, drinking and smoking were linked to a lower level of annual HOPME. The results observed from spouses mirrored those among respondents.

Table 2 incorporated all types of households. Our subsequent analysis was restricted to two-person households exclusively consisting of

[4] The results of the Hausman test suggest that a fixed effects model should be used to evaluate the impact of PA on annual HOPME ($P < 0.0001$).

Table 2
Fixed-effects model for the association between PA and annual HOPME.

Variables	(1)		(2)		(3)	
	β	95% CI	β	95% CI	β	95% CI
PA (Ref: No)	−0.102**	(-0.201, −0.002)				
Frequency of PA (Ref: Never)						
1-2 times per week			−0.198**	(-0.376, −0.019)		
3-5 times per week			−0.178***	(-0.318, −0.038)		
6 times and above per week			−0.056	(-0.164, 0.051)		
Duration of PA (Ref: 0–30 min)						
31–60 min					−0.111**	(-0.216, −0.006)
61–90 min					−0.086	(-0.249, 0.076)
>90 min					−0.050	(-0.173, 0.073)
Age	0.372***	(0.161, 0.583)	0.369***	(0.158, 0.580)	0.374***	(0.163, 0.586)
Gender (Ref: Female)	−0.143	(-2.748, 2.461)	−0.175	(-2.779, 2.429)	−0.124	(-2.731, 2.482)
Self-rated health (Ref: Excellent)						
Very good	−0.007	(-0.217, 0.204)	−0.001	(-0.212, 0.211)	−0.000	(-0.212, 0.212)
Good	0.193*	(-0.007, 0.392)	0.199**	(-0.0005,0.398)	0.196*	(-0.004, 0.396)
Fair	0.212*	(-0.004, 0.428)	0.219**	(0.003, 0.435)	0.219**	(0.003, 0.436)
Poor	0.392***	(0.160, 0.625)	0.400	(0.167, 0.633)	0.396***	(0.162, 0.629)
Depression (Ref: No)	0.078	(-0.043, 0.200)	0.081	(-0.040, 0.203)	0.077	(-0.045, 0.199)
Chronic disease (Ref: No)	0.104**	(0.006, 0.202)	0.103	(0.005, 0.202)	0.106**	(0.008, 0.205)
Drinking (Ref: No)	−0.183**	(-0.341, −0.025)	−0.179**	(-0.337, −0.021)	−0.184**	(-0.342, −0.025)
Smoking (Ref: No)	−0.329***	(-0.528, −0.131)	−0.328***	(-0.527, −0.129)	−0.329***	(-0.528, −0.130)
Years of education	0.015	(-0.012, 0.042)	0.015	(-0.012, 0.042)	0.014	(-0.013, 0.042)
Pensions (Ref: No)	−0.078	(-0.221, 0.065)	−0.077	(-0.219, 0.066)	−0.079	(-0.222, 0.064)
Medical insurance (Ref: No)	0.039	(-0.127, 0.205)	0.035	(-0.132, 0.201)	0.040	(-0.127, 0.206)
Household income	0.046	(-0.023, 0.115)	0.045	(-0.024, 0.114)	0.045	(-0.024, 0.114)
Working status (Ref: No)	−0.101	(-0.256, 0.054)	−0.098	(-0.253, 0.057)	−0.105	(-0.260, 0.050)
Age of spouse	0.003	(-0.003, 0.010)	0.003	(-0.004, 0.009)	0.003	(-0.003, 0.010)
Gender of spouse	0.253	(-1.583, 2.089)	0.204	(-1.633, 2.041)	0.244	(-1.594, 2.082)
Self-rated health of spouse (Ref: Excellent)						
Very good	0.020	(-0.171, 0.212)	0.023	(-0.168, 0.215)	0.022	(-0.169, 0.214)
Good	0.104	(-0.072, 0.281)	0.107	(-0.069, 0.284)	0.103	(-0.074, 0.280)
Fair	0.091	(-0.105, 0.287)	0.088	(-0.108, 0.284)	0.093	(-0.103, 0.289)
Poor	0.344***	(0.133, 0.556)	0.347***	(0.136, 0.558)	0.344***	(0.133, 0.555)
Depression of spouse (Ref: No)	0.089	(-0.025, 0.204)	0.092	(-0.023, 0.207)	0.089	(-0.026, 0.203)
Chronic disease spouse (Ref: No)	0.078	(-0.022, 0.177)	0.079	(-0.020, 0.179)	0.079	(-0.021, 0.179)
Smoking of spouse (Ref: No)	−0.273***	(-0.463, −0.082)	−0.267***	(-0.457, −0.076)	−0.275***	(-0.465, −0.084)
Drinking of spouse (Ref: No)	−0.047	(-0.200, 0.106)	−0.045	(-0.198, 0.109)	−0.043	(-0.196, 0.111)
Years of education of spouse	0.013	(-0.008, 0.034)	0.012	(-0.009, 0.033)	0.013	(-0.008, 0.034)
Pensions of spouse (Ref: No)	0.009	(-0.125, 0.144)	0.009	(-0.126, 0.143)	0.007	(-0.128, 0.142)
Medical insurance of spouse (Ref: No)	0.098	(-0.068, 0.265)	0.098	(-0.068, 0.265)	0.096	(-0.071, 0.263)
Working status	−0.046	(-0.186, 0.093)	−0.045	(-0.185, 0.094)	−0.050	(-0.189, 0.090)
Provinces	Yes		Yes		Yes	
Year	Yes		Yes		Yes	
R-squared	0.079		0.080		0.079	
Observations	4641		4641		4641	

Note: ***p < 0.01, **p < 0.05, *p < 0.1.

respondents and their spouses. The results in Table 3 were consistent with Table 2. PA was negatively associated with annual HOPME (Column 1, β = −0.268, 95% CI: −0.465, −0.071). Participating in PA 1–2 times (β = −0.317, 95% CI: −0.678, 0.044) and 3–5 times (β = −0.402, 95% CI: −0.690, −0.113) per week were negatively associated with annual HOPME (Column 2). Engaging in PA for 31–60 min per session

Table 3
Fixed-effects model for the association between PA and HOPME: two-person households.

Variables	(1)		(2)		(3)	
	β	95% CI	β	95% CI	β	95% CI
PA (Ref: No)	−0.268***	(-0.465, −0.071)				
Frequency of PA (Ref: Never)						
1-2 times per week			−0.317*	(-0.678, 0.044)		
3-5 times per week			−0.402***	(-0.690, −0.113)		
6 times and above per week			−0.163	(-0.363, 0.038)		
Duration of PA (Ref:0–30 min)						
31–60 min					−0.224**	(-0.419, −0.030)
61–90 min					−0.031	(-0.350, 0.289)
>90 min					−0.056	(-0.283, 0.170)
Other variables	Yes		Yes		Yes	
Provinces	Yes		Yes		Yes	
Year	Yes		Yes		Yes	
R-squared	0.122		0.130		0.132	
Observations	1605		1605		1605	

Note: 1) ***p < 0.01, **p < 0.05, *p < 0.1; 2) due to space limitations, we did not report the results of all controlled variables.

corresponded to a 22.4% (95% CI: −0.419, −0.030) lower level of annual HOPME (Column 3).

3.3. Mediating effects analysis

Fig. 2 illustrated the mediating effects of spousal PA in the association between individual PA and HOPME. Fig. 2 demonstrated that individual PA was positively associated with spousal PA ($\beta = 0.186$, $p < 0.01$), and that spousal PA inversely affected annual HOPME ($\beta = -0.221$, $p < 0.05$). The Sobel test disclosed that spousal PA mediated 12.31% of the relationship between individual PA and annual HOPME.

3.4. Heterogeneity analysis

Fig. 3 disclosed the relationship between individual PA and annual HOPME, segmented by age and gender. The results indicated a negative association between PA and annual HOPME among women (Fig. 3b: $\beta = -0.271$, $p < 0.05$), and among individuals aged 45–65 years (Fig. 3c: $\beta = -0.428$, $p < 0.01$). Conversely, this significant association was not observed among men and those aged over 65 years in Fig. 3a and d.

Fig. 3a further showed that male PA was positively associated with female spouse PA, but female spouse PA had no effect on HOPME. Meanwhile, Fig. 3b revealed that female PA was positively associated with male spouse PA ($\beta = 0.178$, $p < 0.01$), and male spouse PA exhibited a negative association with annual HOPME ($\beta = -0.252$, $p < 0.1$). The Sobel model showed the mediating proportion of the total effect was 12.93%. Similarly, Fig. 3c showed that spousal PA played significant mediating role in PA-HOPME among adults aged 45–65 (the mediating proportion of the total effect was 8.42%). Fig. 3d disclosed no statistically significant mediation effects among older people over 65.

4. Discussion

Utilizing data from the 2014–2018 China Family Panel Studies (CFPS), this study delved into the potential relationship between PA and annual HOPME among urban residents aged 45 and over in China. A particular focus of this study was the exploration of the mediating effect of spousal PA on the individual's PA-HOPME relationship. While previous research has extensively examined the link between PA and medical expenditure, there is also a growing body of literature investigating the influence of spousal behaviour on an individual's healthy lifestyle (Carlson et al., 2015; Sato et al., 2019; F. F. Wang et al., 2005). However, to the best of our knowledge, this study represents the first attempt to bridge these two strands of literature by examining how individual PA can influence their spouse's PA, subsequently leading to reduction in household medical expenditure.

Our study disclosed that participation in PA was negatively associated with the annual HOPME. This was consistent with the literature which investigated the relationship between PA and medical expenditure at both the regional level and individual level. For instance, Tsuji et al. (2003) found that the monthly medical expenditure of older adults with chronic disease were higher than healthy population, and PA was an effective way to prevent chronic disease risk and curb the excessive growth of healthcare costs. Several studies examined the relationship between PA and medical expenditure using macro-level (state or county) data, confirming the negative association (Sato et al., 2019, 2020).

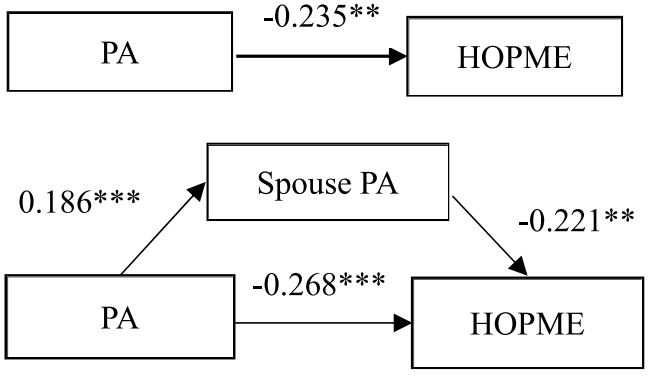

Fig. 2. Mediating analysis of the PA level of spouse.

Moreover, we found that the frequency and duration of PA were closely associated with HOPME. Exercising 1–5 times per week and maintaining exercise duration at 31–60 min per session were effective in reducing annual HOPME. This was similar to previous studies, who found that exercising 1–5 days per week had significant effect on individual medical expenditure (Caretto et al., 2016), and a maximum of 1.5% of total healthcare costs could be saved if all employees kept regular PA (F. Wang et al., 2004). However, the negative association in PA-HOPME was not statistically significant among those individuals who engaging in PA every day and maintaining exercise duration over 60 min. Although several studies attributed this result to self-reporting bias (individuals participating in the physical activity self-assessment questionnaire were subject to social desirability and recall bias, both which could lead to over-reporting) (Christopoulou et al., 2011; Goetzel et al., 2003; Winckers et al., 2015), the potential reason need further investigation.

This study additionally contributed evidence supporting the mediating role of spousal PA in the relationship between individual PA and annual HOPME. Our findings revealed a significant 'spousal motivation effect'. Specifically, individual PA not only directly reduced HOPME but also indirectly contributed to this reduction by enhancing the PA level of their spouse. This finding was consistent with the literature disclosed that spouse can impact one another's health behaviors, through various mechanisms. For instance, one partner could encourage behaviors that promote health (Brazeau & Lewis, 2021; Cobb et al., 2016; Harada et al., 2018), or conversely, may lead to the initiation or intensification of behaviors detrimental to health (Lin et al., 2023; Stimpson et al., 2006).

Furthermore, we found differences in the mediating role of spousal PA among gender and age groups. More specifically, this mediating effect as well as the significant association between PA and medical expenditure only existed among women and those aged between 45 and 65. Our finding echoed the literature on the influence of dynamics within marital relationships on health behaviours, with evidence suggesting that married men were more likely to experience regulation of their health behaviours by their spouses, compared to married women (Cobb et al., 2016; Umberson, 1992). This phenomenon potentially led to better health outcomes among married men. This pattern highlighted the gendered aspects of health behaviour regulation within marital contexts. The observed heterogeneities in PA levels among different age groups can be partly attributed to the notable decrease in PA that typically accompanies advancing age (CDCP, 2020). As individuals grow older, their physical capabilities inevitably tend to decline, potentially limiting the extent to which spousal behaviours can influence PA. This scenario implied a potential reduction in the effectiveness of spousal influence on PA engagement in older age groups.

5. Limitations and conclusions

This study was subject to several limitations. Firstly, this study focused exclusively on urban Chinese population aged 45 and over, primarily due to the complexity of PA measurement in rural areas and substantial regional disparities in access to physical activity facilities. This limited the applicability of our findings to the entire Chinese middle-aged and older population. Secondly, the study's assessment of PA relied on indicators such as PA behaviour, frequency, and duration. These metrics, while informative, did not capture the specific types or intensity of PA. Due to the data limitations, we failed to apply more granular physical activity indicators. Future research should consider

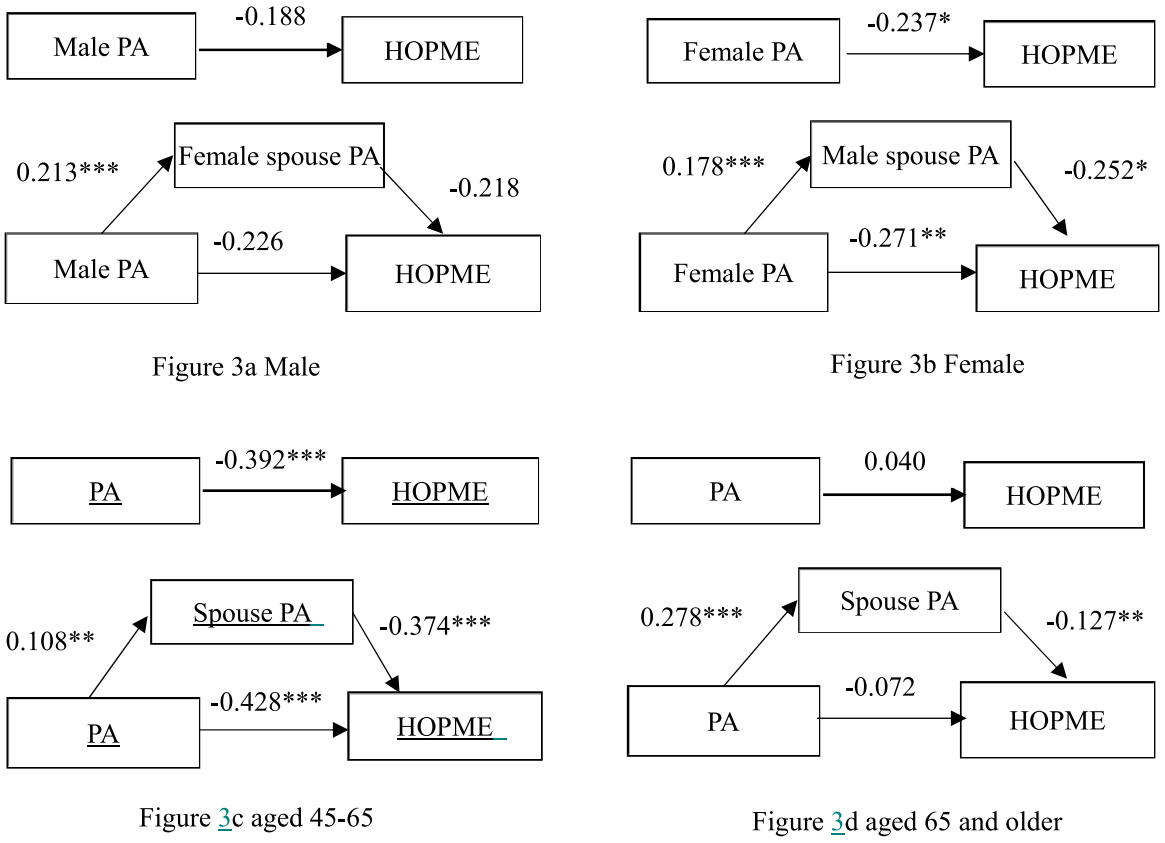

Fig. 3. The regression results of heterogeneity analysis.

incorporating measures of PA that align with public health officials' (such as National Health Commission of China, NHCC or General Administration of Sport of China, GASC) recommended guidelines for a more comprehensive analysis.

Thirdly, although the fixed-effects model used in this study accounted for unobserved confounding variables which were invariant across time, it was not able to control for those change over time (such as living environment) (Blackwell et al., 2001; Moran et al., 2014; Pavela & Latham, 2016). This limitation highlighted the need for caution in interpreting the findings as causal. Additionally, while the study investigated the relationship between individual PA and spousal PA. It did not explore whether PA can similarly influence the PA of other family members. Future research should focus on understanding the impact of PA within different family dynamics on household medical expenditure. Finally, due to data limitation, this study used out of pocket medical expenditure to measure the overall household medical expenditure, which may not accurately represent the total household healthcare costs.

Despite these limitations, this study underscores the potential role of PA in mitigating HOPME among urban residents aged 45 and over. It also reveals the influential role of an individual's PA in promoting spousal PA, which in turn contributes to a reduction in household medical costs. This aspect is especially relevant given the aging population, where an increased demand for health care services is seen as an inherent part of the aging process. Such a trend poses considerable financial and caregiving challenges for families and the broader society. In light of these findings, it is imperative for the Chinese government to implement more strategies aimed at increasing the prevalence and accessibility of physical activity facilities. Enhancing public awareness about the benefits of PA and encouraging regular engagement in physical activities are critical steps towards mitigating the healthcare challenges on individuals and society.

Ethics approval

Ethical approval for the study and written informed consent from the participants of the study were not required as per national legislation and institutional requirements.

Submission declaration

The authors declare that the work described has not been published previously and it is not under consideration for publication elsewhere.

Funding

This research was funded byNational Bureau of Statistics of China (Grant No.2022ZX21), and Philosophy and Social Science Foundation of the Ministry of Education of China (Grant No.19JZD016).

CRediT authorship contribution statement

Xiaodong Zhang: Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Yanan Zhang:** Writing – original draft, Formal analysis, Data curation, Conceptualization. **Bin Guo:** Writing – original draft, Software, Data curation, Conceptualization. **Gong Chen:** Writing – review & editing, Validation, Supervision. **Rui Zhang:** Writing – review & editing, Validation, Supervision. **Qi Jing:** Writing – review & editing, Methodology. **Hafiz T.A. Khan:** Writing – review & editing, Supervision. **Lei Zhang:** Writing – review & editing, Validation, Supervision, Funding acquisition.

Declaration of generative AI and AI-assisted technologies in the writing process

The authors declare that they did not use generative AI and AI-assisted technologies in the writing process.

Declaration of competing interest

The authors declare that they have no competing interests.

Data availability

Data will be made available on request.

Acknowledgements:

Not applicable.

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