

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 Renminbi - RMB; ; Yuan-US Dollar exchange rate was 6.4588 Yuan per US 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 (χ^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 or 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

Region of residence						
North	1149	47.2	657	44.2	492	51.9
South	1286	52.8	830	55.8	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						

No	1590	65.6	849	57.1	741	78.2
Yes	835	34.4	629	42.6	206	21.8
SD: Standard Deviation; -: Not applicable						

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 ($p>0.10$).

			Incidence of Hypertension between 2004 and 2011 (cases and row percentages)			χ^2
			No	Yes	Total	
Leisure time physical Activity in 2004	Whole Sample	No	1781 (87.0%)	267 (13.0%)	2048 (100.0%)	2.064*
		Yes	322 (89.7%)	37 (10.3%)	359 (100.0%)	
		Total	2103 (87.4%)	304 (12.6%)	2407 (100.0%)	
	Urban Residents	No	993 (85.2%)	173 (14.8%)	1166 (100.0%)	3.734**
		Yes	272 (89.5%)	32 (10.5%)	304 (100.0%)	
		Total	1265 (86.1%)	205 (13.9%)	1470 (100.0%)	
	Rural Residents	No	788 (89.3%)	94 (10.7%)	882 (100.0%)	0.134
		Yes	50 (90.9%)	5 (9.1%)	55 (100.0%)	
		Total	838 (89.4%)	99 (10.6%)	937 (100.0%)	

* $p<0.10$; ** $p<0.05$; *** $p<0.01$

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.

	Whole Sample (N=2,213)	Urban Residents (n=1,367)	Rural Residents (n=846)
Variables	Hazards Ratio (95% CI)	Hazards Ratio (95% CI)	Hazards Ratio (95% CI)
Events	286	194	92

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)

High school or above	0.69* (0.46–1.04)	0.63* (0.39–1.04)	0.80 (0.36–1.76)
Health behavior			
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			

Table 3: Hazards ratios for hypertension based on multivariate regressions among sample (n=2,213), urban (n=1,367) and rural (n=846) residents.

Figure 1 shows the mediation effects of BMI and current health status (self-report). After removing them, hazard ratios and 95% CI among the whole sample, urban residents, and rural residents 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.

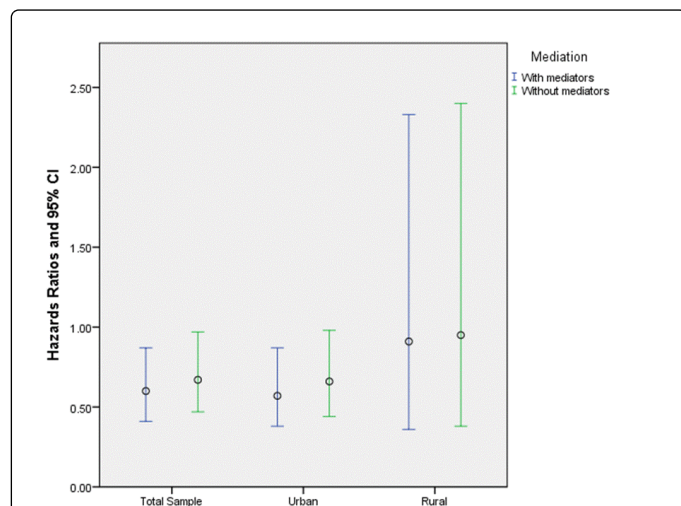


Figure 1: Comparison of hazards ratios and 95% CI of incidence of hypertension with and without mediators.

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 prevalence of hypertension may find promoting leisure time physical activity very useful. In addition, the finding regarding urban and rural disparities may imply that future interventions can be tailored according to intervention settings. Since urban residents may have worse diet and occupational physical activity pattern, it would be beneficial to enhance health behaviors relating to healthy diet and occupational physical activity, in addition to leisure time physical activity among urban residents.

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