Preplanned Studies

Accelerometry-Based Physical Activity and Sedentary Behavior Among Chinese Adults — 7 PLADs, China, 2023

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Summary

What is already known on this topic?

Physical activity (PA) and sedentary behavior (SB) are crucial determinants of both physical and mental health outcomes. However, large-scale studies using objective measurements of these behaviors have not been widely implemented across China.

What is added by this report?

Based on World Health Organization guidelines, 56.8% of participants met the recommendation for moderate-to-vigorous physical activity (MVPA) by accumulating more than 150 minutes per week. Additionally, 37.3% adhered to the SB guideline of less than 8 hours per day. However, only 2.7% of adults achieved compliance with both MVPA and SB recommendations simultaneously.

What are the implications for public health practice?

This study provides novel insights into PA levels and SB patterns among Chinese adults using waist-mounted accelerometry. The observed trends of insufficient PA and excessive SB in this multi-provincial sample emphasize the urgent need for targeted interventions to promote physical activity and reduce sedentary time to foster healthier lifestyle behaviors.

Accurate measurement of physical activity (PA) and sedentary behaviors (SB) is fundamental to evidence-based research, policymaking, and clinical practice. While studies frequently employ subjective methods such as self-report questionnaires to assess PA and SB due to their convenience and cost-effectiveness, these self-reported approaches tend to overestimate PA, particularly at moderate or vigorous intensities, while underestimating time spent in SB (*1*). Accelerometry-based measures of PA and SB have emerged as the gold standard for population-level assessment, offering superior accuracy and practical applicability compared to costly and time-intensive laboratory methods. Despite the widespread adoption of accelerometry in individual studies, comprehensive data on PA and SB levels among Chinese adults from large-scale, representative samples remain notably scarce. This study represents one of the first large-scale initiatives in China to employ waist-worn accelerometry for assessing PA levels and SB under free-living conditions. Drawing from a sample of 2,222 Chinese adults aged 20–79 years across 7 administrative regions, our findings revealed that 56.8% of participants achieved the recommended moderate-to-vigorous PA (MVPA) threshold of at least 150 minutes per week, while 37.3% maintained SB within the recommended limit of 8 hours or less per day. Notably, only 2.7% of adults met both the PA and SB recommendations simultaneously. These results underscore the critical need for targeted strategies to enhance PA and reduce SB, with particular emphasis on developing interventions aimed at promoting active lifestyles and reducing prolonged sitting time.

The study "Accelerometry-Based Physical Activity Levels of Chinese Adults" was conducted from September 5 to December 21, 2023, using a stratified sampling approach. Following the sampling framework of the Normalized National Physical Fitness Surveillance, seven provincial-level administrative divisions (PLADs) were selected from distinct administrative regions based on economic development and project feasibility: Shanxi Province (North China), eastern Inner Mongolia Autonomous Region (Northeast China), Zhejiang Province (East China), Guangdong Province (South China), Hubei Province (Central China), Chongqing City (Southwest China), and Ningxia Hui Autonomous Region (Northwest China). Within each PLAD, one urban and one rural county were randomly selected based on economic development and geographical location. Eligible participants were recruited from within a 3-kilometer radius of testing venues, typically located in community sports centers or physical fitness surveillance centers. Adults aged 20–59 years were recruited through their organizations, while adults aged 60 years and older were recruited through their

communities. Subject recruitment aimed for balanced gender distribution across age groups: 20–29, 30–39, 40–49, 50–59, and ≥60 years. The study received approval from the Institutional Ethics Committee (No. CISSLA-20240219), and all participants provided written informed consent.

The study successfully recruited 2,500 adults aged 20–79 years across the sampling PLADs, with signed consent forms distributed as follows: Shanxi Province (281), Inner Mongolia Autonomous Region (255), Zhejiang Province (536), Guangdong Province (380), Hubei Province (299), Chongqing City (349), and Ningxia Hui Autonomous Region (400). Participants wore ActiGraph GT3X accelerometers (Actigraph LLC, Pensacola, FL, USA) continuously for seven days, including at least two non-workdays, removing devices only during sleep or water-based activities. Nonwear time was defined as any continuous 90-minute period with zero accelerometer counts. Valid wear-time required a minimum of 480 minutes per day for at least three days within the seven-day assessment period (2). Activity intensity categories were classified using Troiano et al.'s three-dimensional cut points (3): sedentary (≤100 counts/min), light PA (LPA, 100–2,019 counts/min), moderate PA (MPA, 2,020–5,998 counts/min), and vigorous PA (VPA, ≥ 5,999 counts/min). Data processing was performed using Actilife (Version 6.1.2.1, ActiGraph Corporation) to compute PA and SB durations, with average daily values calculated for analysis. MPA and VPA were combined to measure MVPA. Following World Health Organization (WHO) Guidelines on Physical Activity and Sedentary Behavior (4), adults aged 18–64 years should accumulate at least 150 minutes of weekly MVPA and limit daily SB to fewer than eight hours for optimal health benefits. Participants were categorized based on their adherence to these guidelines. Statistical analyses were conducted using SPSS 26.0 (IBM SPSS, IBM Corp, Armonk, NY, USA), with group differences assessed via t-tests and analysis of variance (ANOVA). Multiple comparisons employed Bonferroni correction, with statistical significance set at $P<0.05$.

Of the 2,500 initial participants, 2,222 (88.9%) were included in the final analysis after excluding 278 individuals due to invalid accelerometer data or incomplete sociodemographic information. No significant differences in demographic characteristics were observed between those who provided valid PA data and those who did not. The study cohort comprised 1,031 males (46.4%) and 1,607 urban residents (72.3%). The age distribution across decadal groups was: 23.4% (20–29 years), 18.9% (30–39 years), 20.9% (40–49 years), 18.7% (50–59 years), 13.1% (60–69 years), and 5.0% (70–79 years). Based on the Chinese Guidelines for the Prevention and Control of Overweight and Obesity in Adults (5), 36.0% of participants were classified as overweight and 12.7% as obese. Mean daily activity durations were: 465.8 minutes for SB, 128.9 minutes for LPA, 32.7 minutes for MPA, 2.1 minutes for VPA, and 34.8 minutes for MVPA. Rural residents exhibited higher SB compared to urban residents, and adults aged 40–59 years demonstrated greater SB than other age groups. No significant differences in SB were observed across gender or body weight categories. Regarding PA levels, males demonstrated significantly higher engagement in MPA, VPA, and MVPA compared to females. The youngest age group (20–29 years) showed lower MVPA compared to other age groups. Neither residential location nor body weight status was associated with significant differences in MVPA (Table 1).

Based on WHO guidelines for MVPA (4), 56.8% of participants achieved the recommended minimum of 150 minutes weekly MVPA, with males (58.4%) showing slightly higher compliance than females (55.4%). Participants aged over 60 years demonstrated marginally higher compliance (58.1%) compared to those aged 20–59 years (56.5%). Rural residents exhibited significantly higher guideline adherence (55.6%) compared to urban residents (47.1%) (χ^2=9.29, $P<0.05$). Compliance rates showed no significant differences across body weight categories, with similar rates observed in participants with normal weight (57.9%), overweight (56.7%), and obesity (52.7%) (Figure 1).

Following WHO guidelines on sedentary behavior, 37.9% of males and 36.8% of females maintained daily sedentary time below 8 hours. Adults aged 60–79 years demonstrated significantly lower compliance (31.7%) compared to those aged 20–59 years (38.6%) (χ^2=6.65, $P<0.05$). Urban residents exhibited higher qualified sedentary behavior rates (44.5%) compared to rural residents (40.9%), though this difference was not statistically significant. Among body weight categories, 41.0% of obese participants maintained sedentary time below 8 hours daily, while normal-weight and overweight participants showed rates of 36.9% and 36.5%, respectively (Figure 1).

Analysis of combined adherence to both MVPA and

TABLE 1. Daily physical activity levels and sedentary behavior in Chinese adults aged 20–79 years (minutes/day).

Groups	n	SB	LPA	MPA	VPA	MVPA
Total (mean±SD)	2,222	465.8±376.3	128.9±102.3	32.7±33.7	2.1±4.0	34.8±33.5
Total [median (p25, p75)]	2,222	556.4 (629.6, 772.2)	156.0 (193.9, 231.3)	32.4 (45.5, 61.0)	0.4 (1.5, 4.3)	33.9 (48.6, 65.6)
Sociodemographic data		mean±SD	mean±SD	mean±SD	mean±SD	mean±SD
Sex						
Male	1,031	474.2±390.5	127.1±102.0	34.4±33.5	2.5±4.5	36.88±35.98
Female	1,191	458.5±363.9	130.4±102.7	31.2±29.3	1.8±3.6	32.96±31.05
P		>0.05	>0.05	<0.05	<0.01	<0.05
Age, years						
20–29	520	410.7±402.3[†]	104.4±102.8[§]	26.5±28.7[†]	2.1±3.9*	28.6±31.3[¶]
30–39	420	439.6±405.0[†]	110.9±100.3[§]	27.8±27.5[†]	1.9±3.9*	29.7±29.8[§¶]
40–49	464	517.2±393.0*	134.4±100.1[†]	35.3±31.5*	2.3±3.6*	37.6±33.4*[†]
50–59	416	526.6±367.4*	150.4±100.9[†]	41.0±35.5*	2.5±4.7*	43.4±38.0*
60–69	291	450.8±261.1*[†]	157.2±97.0*	35.2±29.6*	1.8±4.3*	37.0±31.1*[†§]
70–79	111	423.0±293.3[†]	134.0±98.7[†§]	31.4±34.6*[†]	1.4±3.3*	32.9±36.3[†§¶]
P		<0.01	<0.01	<0.01	>0.05	<0.01
Area type						
Urban	1,607	354.4±304.1	110.4±100.8	29.4±33.3	1.6±4.2	30.9±35.3
Rural	615	387.0±290.7	125.8±100.0	30.6±30.8	2.0±4.1	32.6±33.0
P		<0.05	<0.05	>0.05	<0.05	>0.05
Body weight status						
Normal weight	1,140	475.5±382.5	129.3±102.6	33.7±32.5	2.12±3.9	35.8±34.6
Overweight	800	462.7±362.6	132.3±101.6	32.6±30.3	2.1±4.1	34.6±32.3
Obesity	282	435.6±388.8	117.8±102.9	29.4±31.0	1.9±4.5	31.3±33.4
P		>0.05	>0.05	>0.05	>0.05	>0.05

Note: For multiple comparisons across age groups, identical superscript letters indicate no statistical difference within subgroups, while different letters denote significant differences between subgroups.
Abbreviation: SB=sedentary behavior; LPA=light physical activity; MPA=moderate physical activity; VPA=vigorous physical activity; MVPA=moderate-to-vigorous physical activity; SD=standard deviation.

sedentary behavior guidelines revealed four distinct categories: participants meeting 1) MVPA recommendations only (54.1%), 2) sedentary behavior recommendations only (34.6%), 3) both recommendations (2.7%), and 4) neither recommendation (8.6%). Figure 2 illustrates the distribution of daily MVPA and sedentary behavior among adults aged 60–79 years through a scatterplot. Only 5.0% of older adults achieved both recommended thresholds (21 minutes per day for MVPA and 480 minutes per day for sedentary behavior), positioning them in the lower right quadrant. Within this age group, 53.1% met only the MVPA guideline, 26.7% met only the sedentary behavior guideline, and 15.2% met neither guideline. Among adults aged 20–59 years, the compliance rates were 2.3% for both guidelines, 54.3% for MVPA only,

36.3% for sedentary behavior only, and 7.1% for neither guideline.

DISCUSSION

This study represents the first large-scale investigation of physical activity and sedentary behavior patterns among Chinese adults using objective measurements from waist-worn accelerometers. Our analysis of 2,222 adults across seven administrative regions revealed that participants averaged 34.8 minutes of MVPA and 465.8 minutes of sedentary behavior daily. While 56.8% of adults met the recommended guidelines for MVPA and 37.3% adhered to sedentary behavior recommendations, only 2.7% achieved compliance with both guidelines simultaneously.
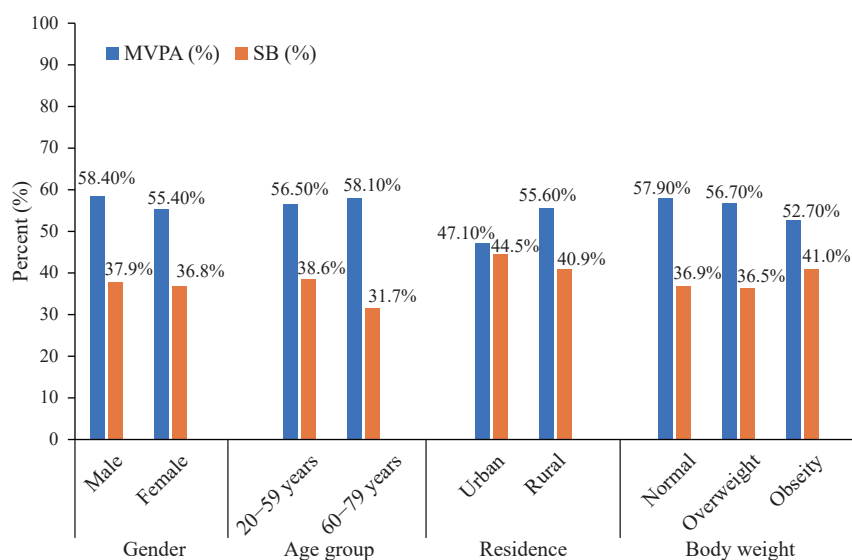
FIGURE 1. Proportion of Chinese adults meeting World Health Organization guidelines for moderate-to-vigorous physical activity and sedentary behavior.
Abbreviation: SB=sedentary behavior; MVPA=moderate-to-vigorous physical activity.
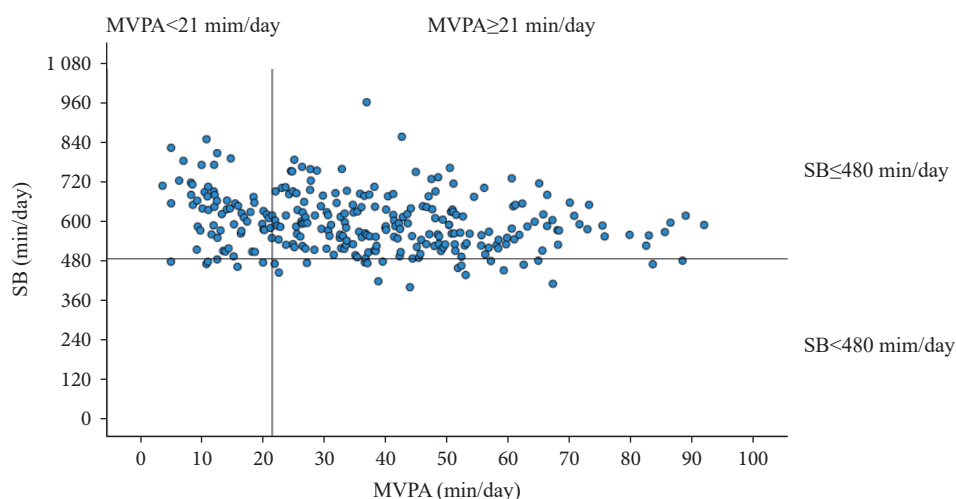

FIGURE 2. Distribution of moderate-to-vigorous physical activity versus sedentary behavior among adults aged 60–79 years, stratified by World Health Organization guideline thresholds (MVPA≥21 minutes/day; SB<480 minutes/day).
Abbreviation: MVPA=moderate-to-vigorous physical activity; SB=sedentary behavior.

Physical activity, characterized by skeletal muscle-induced bodily movement requiring energy expenditure, plays a fundamental role in both physical and mental well-being. Research indicates that physically inactive individuals face a 20% to 30% higher risk of premature mortality compared to their physically active counterparts (6). The World Health Organization's "Guidelines on Physical Activity and Sedentary Behavior" indicates that 25% of adults globally fail to meet recommended physical activity levels (6). Our findings reveal an even more concerning situation in China, where 43.2% of adults do not achieve sufficient MVPA, with daily averages of just 34.78 minutes. This contrasts markedly with findings from the China Kadoorie Biobank (CKB) study, which reported 104.4 minutes of daily MVPA using device-based measurements (7). This substantial disparity likely stems from methodological differences, particularly in device selection and placement. Our study employed waist-mounted ActiGraph triaxial accelerometers, whereas the CKB study utilized wrist-worn Axivity AX3 devices. Previous research has established that device placement significantly influences activity count measurements (8). While

wrist-mounted accelerometers typically demonstrate higher compliance rates, they tend to record substantially higher activity counts compared to waist-mounted devices. For free-living ambulatory assessments, waist-mounted accelerometers are generally preferred due to their broader applicability and high acceptability.

Sedentary behavior, characterized by sitting or reclining postures with energy expenditure below 1.5 times the basal metabolic rate, represents a distinct health risk factor independent of physical inactivity and is associated with numerous adverse health outcomes (*9*). Current guidelines recommend adults limit SB to no more than 8 hours daily. Our findings reveal that 37.3% of Chinese adults exceeded this recommendation. The observed mean daily SB duration of 465.8 minutes (7.8 hours) closely aligns with findings from the China Kadoorie Biobank study, which reported 8.8 hours per day (*7*). These results suggest that excessive sedentary time, rather than insufficient MVPA, may require more urgent intervention among Chinese adults. Implementation of targeted strategies to reduce and interrupt prolonged periods of SB is therefore crucial.

Perhaps the most striking finding from our investigation was the exceptionally low adherence to combined MVPA and SB recommendations, with only 2.7% of the study population meeting both guidelines. This compliance rate was even lower among adults aged 20–59 years (2.3%), though slightly higher in those aged 60–79 years (5.0%). These rates fall substantially below the 12.6% observed in a cohort of 2,338 participants across eight Latin American countries (*10*). This disparity indicates that while many participants achieved adequate MVPA, they simultaneously accumulated excessive sedentary time. Conversely, others maintained appropriate SB levels but primarily engaged in light-intensity activities. These patterns underscore the critical need for targeted interventions designed to simultaneously reduce sedentary time and increase engagement in more vigorous activities. Furthermore, the observed variations in movement behaviors across gender and urban-rural demographics highlight the necessity for population-specific interventions. Notably, the absence of significant associations between PA, SB, and body weight status warrants further investigation.

This study has several notable limitations. Physical activity and sedentary behavior patterns exhibit significant seasonal variations (*11*), with higher activity levels typically observed during summer compared to winter, particularly among active populations. As our data collection occurred during autumn and early winter, future research across different seasons would strengthen the evidence base. Additionally, while the 7-day measurement period provides valuable insights, it may not fully capture long-term habitual movement behaviors. A longitudinal cohort study with extended measurement periods would offer more comprehensive behavioral patterns. Furthermore, although our multi-provincial study design provides important regional insights, caution should be exercised when extrapolating these findings to represent national patterns.

In conclusion, this study presents the first comprehensive assessment of movement behaviors using waist-mounted accelerometry across seven PLADs in China. Our findings reveal that a substantial proportion of Chinese adults maintain insufficient physical activity levels while engaging in excessive sedentary behavior. These results underscore the urgent need for targeted interventions aimed at both increasing moderate-to-vigorous physical activity and reducing sedentary time to optimize health outcomes associated with physical exercise.

Conflicts of interest: No conflicts of interest.

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