

Original article

Associations between individual and environmental factors and habitual physical activity among older Chinese adults: A social–ecological perspective

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Abstract

Purpose: To examine, within a social–ecological framework, associations between multifaceted individual and environmental factors and habitual physical activity (HPA) among older Chinese adults.

Methods: Through a mix of qualitative and quantitative methods, a survey instrument assessing various factors underlying 3 social–ecological dimensions of intrapersonal, interpersonal, and community and environmental resources was developed. Using a cross-sectional design, older adults ($n = 1580$, aged 67 ± 7 years) recruited from 10 communities in Shandong province completed the social–ecological survey of HPA. Data were analyzed using Partial Least Squares Path Modeling.

Results: Factors related to intrapersonal (medical knowledge, motivation, physical function, sport skills, socioeconomic status, and education), interpersonal (social support, social activity, and social norms), and community and physical environmental resources (safety, capacity, availability of and access to physical activity facilities) were found to be significantly associated with older adults' participation in HPA.

Conclusion: The findings provide an initial validation of a social–ecological approach to the study of HPA in China, suggesting that strategies aimed at promoting physical activity in older adults should address multiple levels of factors that may contribute to the likelihood of older Chinese adults being physically active.

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Keywords: Exercise; Interpersonal resources; Intrapersonal resources; Older adults; Physical activity; Social–ecological

1. Introduction

Increases in the length of life and reductions in fertility and mortality in China have contributed to a growing population of older Chinese adults,¹ with the number of individuals ≥ 60 years old increasing from 194 million in 2012 (14.3% of the total population) to 202 million in 2013 (14.8% of the total population).² This increase in the older adult population has been accompanied by a higher prevalence of non-communicable (chronic) diseases.³ It is estimated that about 64% of individuals

aged 65 years and older have at least 1 chronic disease, creating public health and social/economic challenges to China.⁴ In response, the Ministry of Health of China has enacted both short- and long-term national plans (2012–2015)⁵ in an effort to control and prevent the increased incidence and prevalence of chronic diseases in this population, including diabetes, hypertension, heart disease, cancer, and arthritis.

Lifestyle factors such as physical inactivity are known to contribute to the development of many chronic diseases.^{6–8} Therefore, there has been an increased research effort in the past decade in China aimed at identifying various individual, social, physical, and built environmental factors that promote an active and healthy aging process and, ultimately, reduce the incidence of chronic disease.^{9,10} Mounting evidence suggests

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that habitual physical activity (HPA) is associated with numerous health benefits, including reductions in the risk of heart disease, diabetes, cancer, and osteoporosis.^{11–13} Despite this evidence, most Chinese adults do not engage in regular physical activity (PA), and approximately 59% do not participate in any HPA. For the older adults, less than 30% participate in 30 min of PA 3 or more days/week.¹⁴ Common correlates of or barriers to participation in HPA among Chinese adults include individual-level factors such as a lack of time and exercise equipment,^{15–17} the lack of a social support system,¹⁸ lack of motivation,¹⁹ poor health/functional status,¹⁶ busy with housework,²⁰ and low socioeconomic status.²¹ In addition, various social and environmental correlates and determinants have also been identified as being related to PA adherence in older adults.^{22,23}

It is now recognized that there are multiple factors contributing to or correlating with participation in HPA. Thus, addressing this issue requires a multifaceted approach. In this regard, social–ecological models^{24,25} provide a suitable framework for studying the complex interplay among individual, social, and community and environmental factors and the influences that interact and affect the ability of individuals to participate in PA or the likelihood of them doing so.^{26–31} Evidence suggests that a social–ecological approach is effective in identifying and understanding various intrapersonal, interpersonal, community/organizational, and environmental issues/resources that either enable or impede PA, thus influencing the health status of young and adult populations.^{32–43}

In China, there is an obvious absence of research based on social–ecological models that focus on understanding the relationships among individual, social, and organizational/environmental factors and PA in older Chinese adults, a population that faces increasing health and environmental challenges due to the unprecedented economic reform witnessed over the past 30 years.⁹ Thus, the purpose of this study was to adopt a social–ecological framework in order to examine the associations between multifaceted individual and environmental factors and HPA in Chinese older populations. On the basis of past research, we hypothesized that social–ecological-based factors involving intrapersonal, interpersonal, and community and environmental resources would be related to participation in HPA among older Chinese adults.

2. Methods

2.1. Overview of the study design

The study was conducted between 2012 and 2014. The overall design involved a mix of qualitative and quantitative approaches carried out in 3 phases. In Phase 1, using a qualitative approach, we sought to develop a survey instrument specifically designed to test our study hypotheses. In Phase 2, using the information from Phase 1, we evaluated the initial factorial structure of the theoretical constructs entailed in our survey scale. In Phase 3, using the validated survey instrument, we empirically tested the hypotheses in a cross-sectional study. In all phases of the study, community-dwelling older adults were the target population. The study protocol was approved by the

Institutional Review Board of Shandong University, and an informed consent was obtained from each participant.

2.2. Phase 1

The process of constructing the survey instrument included (1) a review of the existing research literature and (2) focus group meetings and interviews with local community stakeholders (i.e., community leaders, administrators, resident representatives) and targeted community-dwelling older adults. The literature review included a synthesis of constructs derived from social–ecological-based studies and measures that involved assessments of intrapersonal/interpersonal and community/environmental resources in PA. Focus group meetings, conducted by the researchers, involved discussions on topics and issues related to policies, social norms, safety, social activity, and community capacity and accessibility pertaining to older adults' PA. These preliminary efforts resulted in the generation of an initial pool of 115 survey items designed to assess various PA resources described below.

2.2.1. Intrapersonal

These items focused primarily on assessing individual characteristics such as health and medical knowledge, motivation, physical function, and sport skills. Items on health and medical knowledge were developed from the 2008 Chinese Citizens' Health Literacy Survey,⁴⁴ which includes questions about health habits, diabetes, and hypertension. Motivation (both intrinsic and extrinsic) was assessed via a Chinese version of the Motivation for Physical Activities Measure⁴⁵ (Cronbach's internal consistency $\alpha = 0.85$). Physical function was assessed via the Chinese version of SF-36⁴⁶ (Cronbach's $\alpha = 0.66–0.94$), with a high value indicating worse physical functioning.⁴⁷ Items related to sport skills were developed by a panel of experts in the areas of both traditional and conventional Chinese sport activities such as Tai Ji Quan, martial arts, table tennis, folk dance, badminton, gate ball, and walking.

2.2.2. Interpersonal

Interpersonal resources focused on dimensions of social support, social norms, and social connection. The social support measure developed by Eyer et al.⁴⁸ was adopted to assess both emotional and informational factors. Measures related to social safety and social connection were derived from the work by Sampson et al.⁴⁹ Finally, the Social Norms for Physical Activity Scale⁵⁰ was used to assess perceived norms at both the organizational/community level and individual level (e.g., neighbor, family, or friends).

2.2.3. Community and environment

These resources focused on community capacity and physical environment. Specifically, community capacity was measured using items developed by Bush et al.⁵¹ and assessed 4 areas: network partnerships, knowledge transfer, problem solving, and infrastructure. Items related to physical environment were developed via a mix of methods using input from focus groups, audits at local facilities on PA access, information on safety issues, information on programs offered, and interviews with stakeholders and older adults.

2.2.4. Initial scale construction

With the assistance of local community leaders, 50 local community-dwelling older adults were interviewed individually to elicit their reactions to the clarity of the writing and content ambiguity in the survey items. Using a Delphi technique, the content of these items was further reviewed and scrutinized by a panel of 15 experts in the areas of public health, exercise instruction, PA research, sports psychology, and epidemiology. The responses from these panel members were examined, and a decision was then made on whether to modify, delete, or add items. During the process, items agreed upon by at least 80% of the panel members were included in a final version of the survey. As a result of these systematic content evaluations, a 100-item initial survey was developed for assessing the 3 general resources: intrapersonal, interpersonal, and community and environmental resources.

The 100 items were incorporated into 12 subscales that represented the different resources identified previously. A Likert-type response format was adopted for the survey. Specifically, scale items that measured intrapersonal and interpersonal resources were anchored on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), whereas items measuring community and physical environment were anchored on a 4-point scale: 1 (*not at all/very limited*), 2 (*somewhat*), 3 (*substantial*), and 4 (*almost entirely/entirely*).

2.3. Phase 2

2.3.1. Participants

A pilot study designed to evaluate the factorial structure of individual and environmental resources was conducted among 400 older adults (65.36 ± 5.68 years). The participants, recruited by resident representatives via telephone, were sampled randomly from a local telephone directory. The response rate of using the telephone recruitment method was 100%. The survey was administered to each participant by a group of local leaders and resident representatives.

2.3.2. Data analysis

Exploratory factor analysis (EFA) was performed (SPSS18.0; SPSS Inc., Chicago, IL, USA) to determine the underlying factorial structure of various resources identified in Phase 1. Since the scale was developed according to an *a priori* determined number of factors, the number of factors was fixed to 12 as identified by the α extraction and promax rotation. The criteria for retaining the factors were based on the eigenvalue being ≥ 1.0 and a value of ≥ 0.50 on factor loading. Under these criteria, 7 items were removed.

The 12 factors underlying the 3 categories of resources included 5 factors that represented intrapersonal resources: individual characteristics (5 items, $\alpha = 0.58$), medical knowledge (4 items, $\alpha = 0.71$), motivation (18 items, $\alpha = 0.77$), physical functioning (14 items, $\alpha = 0.68$), and sport skill (PA type) (5 items, $\alpha = 0.80$). The next set of 3 factors represented interpersonal resources: social support (5 items, $\alpha = 0.86$), social norms (6 items, $\alpha = 0.83$), and social activity (4 items, $\alpha = 0.88$). The final set of 4 factors represented community and physical resources: safety (6 items, $\alpha = 0.77$), community

capacity (18 items, $\alpha = 0.81$), facility (4 items, $\alpha = 0.76$), and PA programs (4 items, $\alpha = 0.71$).

2.4. Phase 3

2.4.1. Participants

The study sampling area covered the city of Jinan in Shandong province. Participants were recruited via a multistage sampling strategy. In the first stage, 5 districts were randomly selected, and 2 neighborhoods from each district were then randomly chosen. With the assistance of local resident representatives, a total of 1613 older adults were contacted and invited to participate. Of these, 33 decided not to participate, resulting in a response rate of 98%. The final sample consisted of 1580 participants (36.7% males, 63.3% females) with ages ranging from 60 to 85 years old (67.11 ± 7.77 years).

2.4.2. Procedure

The study survey was conducted in a local community setting and was administered by a group of graduate and undergraduate student assistants who were trained in the research and survey protocols.

2.4.3. Measures

Participants completed the survey instrument that was developed and evaluated in the first 2 phases of the study. In addition, participants' demographic information (i.e., age, education, income) was obtained. As part of the survey, items on levels of PA were also included. Specifically, 3 items were used to assess self-reported PA in older adults. Using a Yes/No response format, the first item asked whether the respondents participated in at least 150 min/week of PA. The second item assessed HPA frequency, which was anchored on a 4-point scale: 1 (*no activity*), 2 (*1–2 times/week*), 3 (*3–4 times/week*), and 4 (*5–6 times/week*). Using the same scale, the last item assessed duration: 1 (*less than 15 min*), 2 (*15–30 min*), 3 (*30–60 min*), and 4 (*60–90 min*). The items on frequency and duration were used in our structural model analysis.

2.4.4. Data analysis

To test the study hypotheses, Partial Least Squares Path Modeling (SmartPLS Version 2.0; SmartPLS GmbH, Boenningstedt, Germany) was used to examine, simultaneously, relationships among various individual and environmental factors and their associations with HPA among older Chinese adults. The model tested entails a measurement model (with observed variables that were related to their corresponding latent variables) and a structural model that links various individual and environment factors to HPA. The HPA latent factor was defined by the 2 items that measured HPA frequency and duration. The strength of the relationships is presented and evaluated by standardized path (or β) coefficients and their associated test statistics. A *p* value less than 0.05 was interpreted as reaching statistical significance. In addition, psychometric properties of each subscale were evaluated using variance explained (VE) and composite reliabilities (CR), employing the procedures described by Fornell and Larcker.⁵²

3. Results

3.1. Study population characteristics

Demographic information about the study population is presented in Table 1. Overall, the sample was primarily female (63.3%), had a low level of education (90.2% had a high school degree or lower), and had a low level of income (68.9% had a monthly income ≤RMB 2000 (about USD 300)). In terms of HPA, approximately one-third of the participants reported participating at least 150 min/week of HPA. Though no gender difference (59.0% for men, 61.9% for women) was found, HPA declined gradually with increasing age and was more prevalent among those who had an income level between RMB 1000 and RMB 3000.

3.2. VE and CR

Values of VE and CR for the survey scale are presented in Table 2. Reasonable variances were extracted by each construct, ranging from 0.55 (physical function) to 0.65 (social support). These variances represent the “amount of variance captured by the construct in relation to the amount of variance due to measurement error” (p. 45).⁵² Similarly, CR values ranged from 0.75 to 0.90, which was higher than recommended (i.e., >0.70).⁵² These estimates, collectively, indicate that the scale has an adequate convergent validity.

3.3. Structural model

Model estimates for the hypothesized structural relationships are presented in Table 3. As can be seen, all latent variables were significantly associated with HPA. Specifically, perceptions of intrapersonal resources were, in general, positively related to participation in HPA among older Chinese adults. However, impaired

Table 1
Characteristics of the study population (n = 1580).

Variables	HPA		Total (n)	Yes (%)	χ^2	p
	Yes (n)	No (n)				
Gender					1.330	0.249
Male	342	238	580	59.0		
Female	619	381	1000	61.9		
Age (year)					25.210	0.000
60–65	379	259	638	59.4		
66–70	299	159	458	65.3		
71–75	236	135	371	63.6		
>75	47	66	113	41.6		
Education					2.212	0.832
Illiterate	125	90	215	58.1		
Elementary school	179	108	287	62.4		
Middle school	251	169	420	59.8		
High school	315	188	503	62.6		
College	61	43	104	58.7		
University	30	21	51	58.8		
Income (RMB)					14.890	0.005
<1000	144	132	276	52.2		
1000–2000	524	288	812	64.5		
2001–3000	143	85	228	62.7		
3001–4000	118	94	212	55.7		
>4000	32	20	52	61.5		

Abbreviation: HPA = habitual physical activity.

Table 2
Convergent validity of the survey scale.

Construct	VE	CR	Cronbach's α	Community
Intrapersonal resources				
Medical knowledge	0.61	0.76	0.80	0.65
Motivation	0.57	0.80	0.73	0.58
Physical function	0.55	0.83	0.74	0.57
Sport skills	0.61	0.90	0.87	0.63
Socioeconomic status	—	—	—	—
Education	—	—	—	—
Interpersonal resources				
Social support	0.65	0.78	0.78	0.66
Social norms	—	0.90	0.85	0.61
Social activities	0.61	0.75	0.71	0.63
Community and physical environment				
Safety	0.59	0.81	0.74	0.60
Community capacity	0.62	0.76	0.79	0.64
Availability/access to facility	0.58	0.81	0.71	0.59
PA programs	0.57	0.79	0.70	0.50

Note: Data were measured by a single indicator. Abbreviations: CR = composite reliabilities; PA = physical activity; VE = variance explained.

physical function, which was negatively associated with HPA, reduced the likelihood of participating in HPA. For factors related to interpersonal resources, the results show that older adults who had high levels of perceived social support and who followed social norms and participated in social activities were associated with a higher level of participation in HPA. Finally, for the community and physical environmental factors, the results show that older adults who perceived high levels of community safety, capacity, and access to local PA facilities and programs were more likely to report higher levels of HPA.

4. Discussion

In this study, within the social–ecological framework, relationships between a set of individual and environmental factors

Table 3
Path coefficients of the structural model.

Resources	β	SE	t
Intrapersonal resources			
Medical knowledge	0.120	0.050	2.280*
Motivation	0.421	0.052	8.153**
Physical function	−0.401	0.048	7.328**
Sport skill	0.380	0.038	6.344**
Socioeconomic status	0.282	0.032	5.104**
Education	0.130	0.038	2.232*
Interpersonal resources			
Social support	0.393	0.038	6.739**
Social norms	0.196	0.035	3.876*
Social activities	0.183	0.032	3.590*
Community and physical environment			
Safety	0.358	0.045	6.086**
Community capacity	0.136	0.035	2.876*
Availability/access to facility	0.354	0.039	6.315**
PA programs	0.090	0.038	2.104*

* $p < 0.05$, ** $p < 0.01$, associated with habitual physical activity. Abbreviations: β = standardized regression weight; PA = physical activity; SE = standard error.

and participation in HPA among older Chinese adults were examined. Prior to the examination of the theoretical relationships under scrutiny, we used both qualitative and quantitative methods to develop a psychometrically sound survey instrument that allowed us to subsequently test the study's hypothesized relationships. Results from structural equation modeling provide support for our working hypothesis that various theoretical factors underlying intrapersonal, interpersonal, and community and physical environmental resources are associated with older adults' participation in HPA.

With respect to factors related to intrapersonal resources, the results indicate that adequate medical knowledge regarding common diseases/conditions (e.g., hypertension, diabetes), high levels of motivation, sport skills, socioeconomic status, and education were more likely to be associated with participation in HPA among older Chinese adults. Physical function, however, was negatively related to HPA, suggesting that older adults reporting limitations in physical function were likely to be physically inactive or underactive compared to those who reported no limitations. These findings are consistent with other reports that personal knowledge, attitudes, beliefs, and motivation are important in initiating and maintaining HPA.^{35,48} On the influence of socioeconomic characteristics, our findings suggest that both socioeconomic status and level of education were associated with participation in HPA. These findings are consistent with a study from Jiaying, China, indicating that adults having middle or high socioeconomic status tended to exercise more compared to those having lower socioeconomic status.²¹ In regard to education, other studies have shown reduced PA among adults with low levels of education⁵³ and increased PA among those with high levels of education.³³

Our findings also suggest the importance of interpersonal resources such as social support, social norms, and social activities in levels of HPA among older Chinese adults. These findings are congruent with the view that social support for HPA from neighbors, friends, family, and program staff is likely to facilitate HPA participation.⁵⁴ Although not specifically measured in the current study, it is likely that social support and social norms may affect PA indirectly through one's perception of self-efficacy,⁵⁵ which has been shown to consistently predict PA.^{33,42,56} Therefore, future studies should expand our current model to take into account the potential role of self-efficacy among older adults in mediating the relationships between social factors and HPA. Finally, engagement in social activities was also shown to correlate with HPA. This finding is consistent with a study conducted in Shanghai that demonstrated that older adults who participated in neighborhood-based social activities were likely to report higher levels of leisure time PA.³⁴

Community-level factors were also shown to be important in regard to HPA participation among older Chinese adults. Our findings suggest that factors such as community safety, social activities, capacity, and availability and access to PA-related facilities were likely to be associated with increased levels of HPA among older adults. Past studies conducted both in China and other countries have consistently shown that positive social and built environmental features such as neighborhood safety,^{33,36,37,57} high social cohesion^{33,34,37} and engagement,³⁴

high walkability,^{37,58,59} and availability of and accessibility to PA facilities^{33,36,57,58,60} were associated with increased HPA or utilitarian PA (e.g., walking for transportation).

4.1. Future research

Future efforts should focus on mechanisms through which some of the multilevel factors may either mediate or moderate HPA outcomes. For example, a study by McNeill et al.³⁹ suggests that individual perceptions of self-efficacy play an important role in mediating the relationships between social and physical environment and PA and that social support influences PA indirectly through one's intrinsic and extrinsic motivation. Also, social and physical environments may interact with individual-level factors. For example, community resources may be important in facilitating HPA in older adults; however, individual factors such as self-efficacy, motivation, and physical function may influence people in using these available resources to engage in HPA. Finally, given that most PA takes place in social and built environments,²⁹ a multilevel approach is needed to delineate level-specific and cross-level influences of social and physical determinants of HPA.^{9,29} This approach will allow us to identify potentially modifiable factors that can inform policies and facilitate the design of interventions to change PA behavior at the societal level.

4.2. Public health implications

There is an increasing need for PA programs in China in order to promote population health.⁹ This study contributes to the sparse literature in the field of aging and PA in China by providing preliminary evidence regarding the important individual and social/physical environmental factors that may contribute to participation in HPA among older Chinese adults. Some of the important public health implications derived from this study include following:

- (1) Older adults' perceptions about chronic diseases/conditions and physical function are important when designing community-based exercise and HPA programs.
- (2) HPA may vary by socioeconomic characteristics, such as an individual's income or education. Therefore, it is important to provide affordable and accessible PA facilities in promoting HPA in communities or neighborhoods with varying levels of socioeconomic status.
- (3) Promotional strategies encouraging HPA need to maximize positive social support and enhanced cultural norms about the importance of HPA. This will create opportunities for engaging in meaningful community-based social activities for older adults.
- (4) Salient social, physical, and built environmental factors are of high importance when promoting community-based HPA among older adults. Community-living environments that are safe in regard to traffic and/or crime, that have good connectivity and are in close proximity to HPA facilities, that have capacity in mobilizing local HPA resources, and that have accessible facilities with rich PA programs are likely to encourage older adults to participate more frequently in HPA.

- (5) Rather than focusing on individual-level factors, HPA programs and interventions are more likely to be successful and effective when they address multiple levels of factors or resources in a large social and community environment.

4.3. Strengths and limitations

This study has several strengths. First, it is one of the first studies that specifically evaluated the influences of individual and social/physical environmental factors on HPA among older Chinese adults. From this perspective, the study is significant because it addresses an important but relatively unexplored public health issue in the Chinese aging population.⁹ Second, the study was hypothesis-driven and was built on a well-established social–ecological framework, thus providing scientific validation of this theoretical approach in the context of PA participation in China. Third, it uses both qualitative and quantitative approaches to understanding the influences of social–ecological factors associated with participation in HPA among older adults. The qualitative component allowed us to provide a clear description of individual and contextual factors in naturalistic settings in order to gain a better understanding of conditions that influence HPA in older Chinese adults.

This study also has some significant limitations that may affect the generalizability of its findings. First, although the study's cross-sectional design was useful in the preliminary stages of the project, it limits our ability to make causal inferences. Future longitudinal studies are needed to better understand how various factors influence PA participation over time. Second, like many other studies conducted in China,¹⁰ notable limitations exist in our HPA measures in that (1) we used a generic assessment of PA domains and (2) the measures relied on self-reports, which are known to be subject to bias. Future studies should consider a combination of self-reports and objective assessment that entails various domains of PA (e.g., leisure time PA, traditional Chinese sport activities, utilitarian walking/cycling). Finally, because of the multistage sampling, it is likely that clusters of participants recruited from the same district/neighborhood shared similarities in demographic and/or lifestyle characteristics that may have led to reduced variability in responses. Given that we analyzed the data at the individual level and did not take this clustering into account, this cluster sampling will not only impact standard errors of estimates but also reduce the power of the study. Therefore, future studies should consider proper adjustments for this clustering effect by using a multilevel modeling approach to the hierarchical data structure that is often encountered in community-based epidemiological studies.

5. Conclusion

This study provides an initial validation of a social–ecological approach to the study of HPA among older Chinese adults. The findings suggest that public health intervention strategies aimed at promoting HPA in older adults should recognize multiple levels of influences that may either enhance or impede the likelihood of PA among older Chinese adults.

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Authors' contributions

XY participated in the design, data collection and analysis, and writing of the manuscript. ZP, ZG, SW, and FP participated in study design, data analysis and drafted the manuscript. JY, ML, PW, JX, and RW participated in design, collecting data, and coordination. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

None of the authors declare competing financial interests.

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