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Epidemiology of Physical Function Impairment in Global Chinese Aging Population: A Systematic Review

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Abstract

Background: Physical function is a cornerstone of geriatric medicine. Impairment in physical function may threaten one's ability to live independently and is associated with multiple negative health outcomes. Although Chinese people is one of the fastest growing populations in the world, there is a limited understanding of the epidemiology of physical function impairment in the global Chinese aging population.

Methods: Researchers used the PRISMA statement and performed a comprehensive online search to highlight the global epidemiology of physical function impairment of Chinese older adults in terms of prevalence, incidence, risk and protective factors, and health consequences. Search items include Chinese, older adult, Asian elderly, aging, physical function, physical function impairment, disability, function impairment, functional dependence, functional limitation, mobility, ADL, IADL, Nagi, and Rosow-Breslau.

Results: Eighty-two papers met inclusion criteria. Prevalence of ADL impairment ranges from 3.0% to 11.6%, while prevalence of IADL impairment ranges from 7.9% to 50.2%. Common risk factors include older age, female gender, lower education, lower income, rural residences, unmarried status, chronic diseases, depression/depressive symptoms, cognitive impairment, and falls. Health outcomes include suicidal ideation/attempted suicide, depression/depressive symptoms, cognitive impairment, falls, and mortality.

Conclusion: The prevalence of physical function impairment among Chinese aging population varies across regions and the number of physical function impairments increases over time. Physical function is influenced by multiple aspects, including socio-demographic characteristics, health conditions, and health behaviors, and can lead to adverse health outcomes. Future longitudinal research is necessary to explore the regional differences, effectiveness of existing intervention programs, as well as the cultural contexts of physical function impairment. Concerted support from caregivers, healthcare and social service providers, and policy makers is necessary to improve physical function and promote healthy aging among Chinese older adults.

Introduction

Physical function is an important indicator of an older adult's current health status. Subsequent impairment, often referred to as physical disability, mobility disability, or functional limitation [1], may bring growing healthcare, social, and economic burdens to society, especially as physical function may decline as people age [2]. Increased life expectancy further implies higher risk of physical function impairment [3-6]. Additionally, impairment in physical health among older adults has been linked to comorbidities [7,8], incident falls [9], pain [10], and mental disorder [11,12], which could further compromise older adults' quality of life and even be predictive of mortality [13,14], and may also raise concerns of caregiving burden [15], living environmental hazard [16-18], social engagement [19], and social circumstances [20,21].

Understanding physical function in Chinese older adults is important. According to the 6th Chinese National Population Census in 2010, the proportion of Chinese older adults aged 60 and above within the general population has increased from 8.0% to 13.3% within 20 years [22] and is projected to reach 19.3% by 2025 [23]. By 2050, it is estimated that 25% of the world's aging population will be Chinese [24]. As one of the fastest growing aging populations in the world [23], the Chinese older adult population may experience a great risk of physical function impairment, which is a serious social and public health concern. However, while many studies have been done in western countries to examine physical function among older adults, little is known in the Chinese aging population, especially among overseas Chinese population. Integrating existing information about physical function impairment among different Chinese communities can help to provide population estimates for the older adults in China and globally, as well as to direct future study and policy making.

The possible differences and similarities of physical function impairment between Chinese aging population and other racial groups warrant attention. Cultural differences may shape the understanding of disease prevention, health maintaining, and treatment [25]. In addition, genetic factors, life style, health care disparities may also partially contribute to the varied health status across different racial groups [26,27]. There is growing evidence reported that U.S. immigrants have poorer physical function compared to their US born counterparts [28]. Research has indicated worse physical health among Asian Americans compared to non-Hispanic white, and Chinese subgroup has the highest rate of prevalence of limited physical function compared to other Asian subgroups [29]. Chinese immigrant aging population may face a higher risk of poor health

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status due to cultural and linguistic barriers, social isolation, healthcare disparities, and acculturation [27]. Evidence has also suggested that relocation and loss of native support network might lead to health disparities among Chinese population [30-34]; the distress of being old combined with immigration-related barriers may make Chinese immigrant aging population even more vulnerable [35]. Furthermore, Chinese aging population may be impacted by barriers of access to health care including language, help-seeking behaviors, and traditional Chinese thinking [25,36], which may lead to delayed care and treatment, and increase the likelihood of having physical function impairment.

Although risk/protective factors and health consequences of physical function impairment in general aging population has been identified in prior studies [9,13,19,37-48], the situation may differ among Chinese older adults due to a variety of socioeconomics, culture beliefs, health literacy, available social services, and access to healthcare resources [49]. Additionally, given the unique cultural characteristics of Chinese population, older adults may expect more care and support from family members, known as "filial piety" [50], especially for those have difficulty in daily task performance. Prior research suggested that a higher level of filial piety is associated with better self-rated health for older adults [51]. However, providing caregiving is likely challenging for immigrant adult children due to cultural and linguistic barriers. Furthermore, Chinese older adults who suffer physical function impairment may face potential elder abuse and discrimination from others [20,52]; additionally, poor health or disability can be especially stigmatized in Chinese culture [21]. These cultural components play important roles which may mediate the relationships between physical function impairment, its risk/protective factors, and health outcomes. Moreover, looking at physical and functional impairment among Chinese aging population across countries and geographic areas can help us understand differences and similarities between populations and provide more comprehensive and better focused recommendations for health promotion. Last, understanding the epidemiology of physical function among Chinese older adults may effectively direct the allocations and uses of limited health care and social-care resources, as well as the development of future strategy at both macro and micro levels.

Despite the increasing awareness on physical function impairment among older adults, there has not been a systematic review of physical function impairment in global Chinese aging population. The purpose of this review is to improve our understanding of the epidemiology of physical function impairment among the global Chinese population including its prevalence, incidence, risk and protective factors, and health consequences, and also aims to collect evidence and extract information for directions for future research and health policy.

Materials and Methods

By using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, this review includes articles that discuss physical function problems among Chinese older adults globally. Inclusion criteria for this review paper are studies that report prevalence or incidences of physical function impairment, as well as risk factors, and health outcomes. Eligible studies focus on older adults aged 50 years old or above who self-identify as ethnic

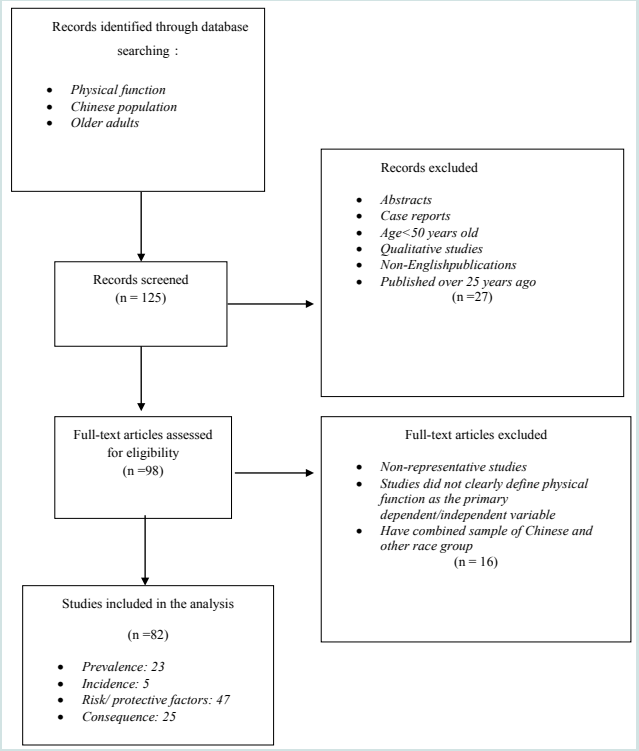

Figure 1: Flowchart describing review process for identification of eligible studies.

Chinese. The global literature was searched in the databases PubMed, MEDLINE, PsychInfo, China Knowledge Resource Integrated Database, and Wan Fang Data. Search keywords include: "Chinese", "older adult", "Asian elderly", "aging", "physical function", "physical function impairment", "disability", "function impairment", "functional dependence", "functional limitation", "mobility", "ADL", "IADL", "Nagi", and "Rosow-Breslau". One review also identified and examined for relevant articles [38]. To refine our review, full manuscripts were further screened to eliminate ineligible articles. Exclusion criteria were: abstracts or case reports, qualitative studies, published over 25 years ago, written in non-English language, combined sample of Chinese and other race group, did not clearly define physical function as the primary dependent or independent variable, and examine the aggregate of physical function and other factors (Figure 1).

Results

There are a total of 125 articles identified through the online database search, and 82 of them met inclusion criteria. These 82 articles discussed physical function problems among Chinese older adults in Mainland China (n=35), Hong Kong (n=22), Taiwan (n=16), Singapore (n=2), and North America (n=7). Three papers have cross-city samples. Among eligible articles, 23 included the information regarding prevalence of physical function impairment, 5 reported the incidence of physical function decline and trends in physical function, 47 examined the risk and protective factors associated with physical function impairment, and 25 evaluated the health consequence related to physical function impairment. Author,

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Table 1: Prevalence of physical function impairment in Chinese aging population.

Author, Year	Study Design	Population	Survey Method	Participation rate, %	Measure (No. item)	Cutoff Points	Sample Selection	Key Findings
Mainland China								
Liang, 2014 [54]	PS; 9 years	7,845 CHNS participants; age ≥60. In 1997: age: mean (SD)=69.1(6.9); F: 54.3%. In 2006: age: mean (SD)=69.7(7.0); F: 53.1%.	In person	34.7; 15.7	Self-reported ADL (5)	≥1 items	Random	ADL disability in 1997: 13.2% ADL disability in 2006: 9.9%
Gu, 2009 [53]	PS; 10 years	22,203 older adults participating the 1992 OSSCE and the 2002 CLHLS; age ≥65; F: 52.2% in OSSCE, 57.3% in CLHLS.	In person	NA	Self-reported ADL (4)	≥1 items	Random	ADL disability in 1992: 7.91% ADL disability in 2002: 7.27%; Annual ADL decline: 1.72% (M); 0. 50% (F), NS. Annual decline in poor self-rated health: 2.4% (M); 2.7 % (F).
Welmer, 2014 [55]	CS	1,451 older adults in Xing Long Zhuang; age ≥60; F: 59.0%	In person	NA	Self-reported functional dependence (≥1 ADL or IADL limitation)	≥1 items	NR	Functional dependence: 15.3%
Zeng, 2015 [66]	CS	395 older adults in Yanqing; age ≥65, mean (SD)=72.4(4.9) for M, 72.4(4.3) for F; F: 49.6%.	In person	91.4	Skeletal muscle mass (SMM); 6-m gait speed (GS); handgrip strength (HS)	Low SMM: <7.61 kg/m2 (M), <6.43 kg/m2 (F); Low HS: <27 kg (M), <16 kg (F); Low GS: <0.98 m/s (M), <0.88 m/s (F)	NR	Low SMM: 9.55% (M); 6.63% (F); Low HS: 14.07% (M); 15.38% (F); Low GS: 20.10% (M); 18.46% (F)
Zhang, 2015 [119]	CS	8,399 older adults in Shanghai; age: ≥60, mean (SD)=72.1 (9.2); F: 53.26%	In person	98.52	Self-reported IADL (8)	≥1 items	Random	IADL disability: 16.51%
Yang, 2015 [87]	CS	616 older adults in Chengdu and Suining; age ≥60, mean (SD)=70.7 (6.8); F: 58.4%	In person	69.4	Self-reported mobility disability	Inability to walk 0.25 mile or to climb 10 steps without resting.	NR	Self-reported mobility disability: 8.9%
Yang M,2014 [57]	CS	738 older adults in Dujiangyan; age ≥90, mean (SD)=93.5 (3.2); F: 68.4%	In person	84.8	Self-reported ADL (6); IADL (8)	≥1 items	NR	ADL or IADL disability: 53.6% (M); 71.3% (F)
Yang, 2014 [58]	CS	616 older adults in Chengdu and Suining; age ≥60, mean (SD)=70.7 (6.8); F: 58.4%	In person	69.4	Self-reported ADL (6); IADL (6)	≥1 items	NR	ADL disability: 10.7% (M); 10.2% (F). IADL disability: 15.9% (M); 15.3% (F).
Alhajj, 2010 [160]	CS	2,199 individuals in Qiqihar, Heilongjiang. Among them, 140 participants aged ≥65; F: 47.5%	In person	97.1	Self-reported ADL; IADL	≥1 items	NR	Among participants aged 65-84, the prevalence of disability was 23.6%.
Xu, 2009 [59]	CS	875 older adults born at the Peking Union Medical College Hospital of China from 1921 to 1941; age ≥68; gender ratio: NA	In person	NA	Self-reported ADL	NA	NR	ADL limitation rate: 11.5%
Tang, 1999 [23]	CS	3,440 older adults in Beijing; age ≥60, mean (SD)=71(7.7); F: 50.4%	In person	88.4	Self-reported ADL (6); IADL (8)	≥1 items; Being dependent on items “needing some help” or “needing complete help”.	Random	Functionally dependent in ADL: 6.5% Functionally dependent in IADL: 7.9%

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Zhang, 1998 [62]	CS	3,745 older adults in Shanghai; age ≥65; gender ratio: NA.	In person	NA	Self-reported ADL (5)	≥1 items	NR	ADL limitation: 8.28%
Chen, 1995 [63]	CS	3,745 older adults in Shanghai; age ≥65; gender ratio: NA.	In person	99.5	Self-reported ADL (5)	≥1 items	NR	ADL impairment: 8.3%
Hong Kong and Tai Wan								
Zimmer, 2002 [68]	PS; 6 years	2,989 older adults in 1993, 2,963 in 1996, and 2,890 in 1999 in Taiwan; age ≥65; mean age: 71.8 in 1993, 72.4 in 1996, 73.2 in 1999; F: 43.3% in 1993, 43.3% in 1996 and 45.4% in 1999.	In person	91.0; 89.0; 89.0	Self-reported walking and climbing limitations	≥1 items	Random	Having ≥1 limitation: 25.5% in 1993; 30.1% in 1996; 35.7% in 1999. Having both limitations: 14.4% in 1993; 16.4% in 1996; 24.1% in 1999.
Lan, 2009 [101]	CS	10,596 older adults in Taiwan; age ≥65, mean (SD)=78.1(7.5); F: 62.4%	In person	72.5	Self-reported ADL (7); IADL (8)	No disability: no difficulty in ADLs or IADLs; Mild disability: have difficulty in ≥1 IADL items; Moderate disability: inability, using assistive devices, or needing assistance in doing 1 or 2 ADLs; Severe disability: inability, using assistive devices, or needing assistance in ≥3 ADLs.	Multistage sampling	Moderate disability: 19.5% Mild disability: 14.6% No disability: 14.4%
Chou, 2008 [60]	CS	2,003 Hong Kong older adults in 1996, 2,180 in 2000, and 4,812 in 2004; age ≥60; F: 53.0% in 1996, 51.4% in 2000, and 51.4% in 2004.	In person	NA	Self-reported ADL (6)	≥1 items	Random	ADL limitation decreased from 4.9% in 1996 to 3.0% in 2000, but increased to 6.9% in 2004.
Woo, 1996 [161]	CS	2,032 older adults in Hong Kong; age ≥70; F: 50.8%	In person	NA	Self-reported functional ability (the Barthel Index)	NA	Random	78.6% had no disability in any areas (Barthel Index=20).
North America								
Dong, 2014[1] [56]	CS	3,159 older adults in Chicago; age: 60-105, mean (SD)=72.8 (8.3); F: 58.9%	In person	91.9	Self-reported ADL (8); IADL (12); R&B (3); Nagi (5).	≥1 items	Convenience	ADL impairment: 7.8% IADL impairment: 50.2% ADL or IADL impairment: 50.4%
Kim, 2010 [125]	CS	51,048 Asian Americans (23,941 Chinese) in California; age ≥60, mean (SD)=71.6 (0.7); F: 55.1% for Chinese subgroup	In person	NA	Self-reported disability*	≥1 items	Random	Chinese: 33.2% (the lowest) Japanese: 36.8% Korean: 37.5% Filipino: 48.8% Vietnamese: 76.4%
Coustasse, 2008 [29]	CS	738 Asian Americans (190 Chinese) in the National Health Interview Survey; age ≥65; gender ratio: NA	In person	NA	Self-reported ADL (6); IADL (8)	Disability: need help in ADI or IADL	NR	ADL disability: Asian American: 7.1%; Chinese: 11.6% (the highest). IADL disability: Asian American: 12.2%; Chinese: 17.3% (the highest)
Cross Cities								

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Zimmer, 2007 [65]	PS; 3 years	Beijing: 2,458 older adults in 1994 and 2,043 in 1997; age ≥60, mean=68.2 in 1994, 68.8 in 1997; F: 50.1% in 1994 and 51.1% in 1997. Taiwan: 3,584 older adults in 1996 and 3,591 in 1999; age ≥60, mean=69.5 in 1996, 69.8 in 1999; F: 45.2% in 1996 and 46.9% in 1999.	In person	NA	Self-reported ADL; IADL; Nagi	≥1 items	NR	Beijing (1994 vs. 1997): ADL limitation: 4.9% vs. 4.7%, NS; IADL limitation: 13.4% vs. 17.7%; Nagi limitation: 9.4% vs. 13.9%. Taiwan (1996 vs. 1999): ADL limitation: 7.6% vs. 9.2%; IADL limitation: 24.3% vs. 25.1%, NS; Nagi limitation: 43.4% vs. 50.9. OR-follow-up vs. baseline: 1) ADL limitation Beijing: 0.94, NS Taiwan: 1.24 2) IADL limitation Beijing: 1.39 Taiwan: 1.04, NS 3) Nagi limitation Beijing: 1.56 Taiwan: 1.35
Feng, 2011 [64]	CS	4,639 older adults in Shanghai, 2,397 older adults in Singapore; age ≥55, mean (SD)=68.3 (7.8) for Shanghai, 65.6 (7.2) for Singapore; F: 56.9%	In person	NA	Self-reported ADL (8)	≥1 items	NR	ADL disability Shanghai: 5.0%; Singapore: 1.8%
Woo, 2008 [162]	CS	Hong Kong: 2,032 older adults, age ≥70, mean age=79.7, F: 50.8%. Urban Beijing: 1,087 older adults, age ≥70, mean age=77.6, F: 50.4%. Rural Beijing: 575 older adults, age ≥70, mean age=77.6, F: 49.6%.	In person	NA	Self-reported ADL (6)	NA	Random	% of functional dependent: Rural Beijing: 4.9%-35.3%; Urban Beijing: 1.7%-20.9%; Hong Kong: 3.1%-13.7%

ADL: Activities of Daily Living; CHNS: China Health and Nutrition Survey; CLHLS: Chinese Longitudinal Healthy Longevity Survey; CS: Cross Sectional Study; F: Female; GS: Grip Strength; HS: Handgrip Strength; IADL: Instrumental Activities of Daily Living; M: Male; Nagi: Nagi Index Of Basic Physical Activities; NR: Not Reported; NS: Not Significant; OR: Odds Ratio; OSSCE: Old-Age Support Survey of Chinese Elderly; PS: Prospective Study; R&B: Rosow and Breslau Index of Mobility; SMM: Skeletal Muscle Mass.

*Disability status was examined in six aspects: having difficulty in 1) dressing, bathing, or getting around the inside home; 2) going outside home alone; 3) walking, climbing stairs, or carrying; 4) basic physical activities; 5) severe vision or hearing problems or blind or deaf; 6) working at a job.

[1]Cronbach's alpha: 0.92 for ADL, 0.90 for IADL, 0.80 for R&B, and 0.80 for Nagi.

year, study design, population and setting, key independent variables, covariates, outcomes and key findings are presented in Tables 1-4.

Prevalence

Prevalence of older adults' physical function impairment varies across different Chinese communities depending on the setting, research methods, and measurements. Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) limitations are most commonly measurements used to assess one's physical function. The majority of studies used "difficulty in completing at least one item of daily tasks" as the cut-off point of ADL or IADL impairment [53-55]. The rates of ADL impairment ranged from 3.0% to 11.6% among global Chinese communities [23,29,56-64], while the rates of IADL impairment ranged from 7.9% to 50.2% (Table 1) [23,29,56,57,61]. Further, the prevalence of physical function impairment was relatively higher among Chinese population compared to other ethnic or racial groups. For example, the National Health Interview Survey of 738 Asian American older adults suggested that the Chinese subgroup experienced the highest ADL or IADL disabilities (11.6% ADL vs. 17.3% IADL impairment) compared to other subgroups of Asian Americans (Filipino: 8.3% ADL vs. 15.3% IADL impairment; Asian Indian: 4.6% ADL vs. 9.1% IADL impairment) [29]. Additionally, studies also report that Chinese older adults living in Chicago had a higher prevalence of IADL impairment in comparison with other Chinese older adults in Mainland China [23,56,61].

In addition to ADL and IADL measurements, researchers have used other assessment tools to evaluate Chinese older adults' physical function, such as Nagi index of basic physical activities and Rosow and Breslau index of mobility [56,65]. A recent paper documented that the rate of self-reported mobility disability was 8.9% in males and 8.5% in females among 616 community-dwelling older adults aged 60 or above in Chengdu and Suining [58], while another paper reported that the rate of low skeletal muscle mass was 9.55% in males compared to 6.63% in females based on a survey of 432 older adults aged 65 or above in Yanqing [66].

Incidence

Most papers reported that an increasing proportion of older adults experience physical function impairment over time (Table 2) [61,67-70]. For instance, the Chinese Longitudinal Healthy Longevity Survey, a four-year follow-up study of 11,112 older adults across China, reported that the rate of ADL disability onset was 9.67%

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Table 2: Incidence of physical function impairment in Chinese aging population.

Author, Year	Study Design	Population	Survey Method	Participation rate,%	Measure (No. item)	Cutoff Points	Cronbach's alpha	Key Findings
Mainland China								
Yang Y, 2015 [67]	PS; 4 years	11,112 CLHLS participants; age ≥65, mean=83; F: 52.32%	In person	69.4	Self-reported ADL (6)	≥1 items	0.89	Onset of ADL disability: 9.67%
Zimmer, 2013 [70]	PS; 15 years	3,257 older adults in Beijing; age ≥70 mean: 75.7 to 77.7; F: 50%	In person	81.2%	Self-reported ADL (6)	≥1 items	NA	ADL disability increased by 0.96% per year for M, but declined by 1.15% per year for F. 0.48% decline of ADL disability.
Beydoun, 2005 [61]	PS; 3 years	976 CHNS participants, in the 1997 and 2000 waves; age ≥55, mean (SD)=63.7(6.22); F: 48.1% in 1997.	In person	NA	Self-report ADL (7); IADL (5)	≥1 items	NA	Overall incidence proportions of any functional status decline: 25.8% IADL decline: 18.9% ADL decline: 6.9%
Hong Kong and Tai Wan								
Zimmer, 2002 [68]	PS; 6 years	2,989 Taiwan older adults in 1993 2,963 in 1996, and 2,890 in 1999; age ≥65, mean=71.8 in 1993, 72.4 in 1996, 73.2 in 1999; F: 43.3% in 1993, 43.3% in 1996, and 45.4% in 1999.	In person	91.0; 89.0; 89.0	Self-reported walking and climbing difficulties	Self-report	NA	Having ≥1 limitation: A 31% increase from 1993 to 1996; a 65% increase from 1996 to 1999. Having both limitations: An 18% increase from 1993 to 1996; a 90% increase from 1996 to 1999.
Woo, 1998 [69]	PS; 18 months	2,032 older adults in Hong Kong; age ≥70; F: 50.8%	In person	60%	Self-reported Barthel Index	Severe limitation (Barthel Index <15); Mild to moderate limitation (Barthel Index 15-19).	NA	Onset of functional impairment: 19.6%.

ADL: Activities of Daily Living; CLHLS: Chinese Longitudinal Healthy Longevity Survey; F: Female; IADL: Instrumental Activities of Daily Living; M: Male; PS: Prospective Study.

[67]. Additionally, these trends may differ by gender. A community-dwelling study conducted in Beijing reported that the ADL disability increased by 0.96% per year for males over a 15 years follow-up, while declining by 1.15% per year for females [70].

Risk and Protective Factors

Social demographic factors

In terms of demographic factors, older age, female gender, lower socioeconomic status, and lower education levels are common risk factors of physical function impairment among Chinese older adults (Table 3) [23,29,54,56,60,61,64,65,71-84]. Previous research among Chinese older adults documented that older age was significantly associated with higher risk of physical function impairment [23,29,56,60,65,71,77,78,80-83]. Interestingly, a study of 7,845 Chinese older adults found that young-old older adults (60-69 years old) experienced higher severity of ADL impairment compared to an older subgroup (70 years old and above) [54]. Additionally, gender is another widely discussed predictor of physical function impairment; multiple studies indicated females are more likely to suffer physical disability or other ADL/IADL difficulties than males [29,54,56,65,71-75,82,84]. Further, two studies reported that older adults with lower socio-economic status or lower income have a higher proportion of worsening functional status [61,80], while another study concluded that absolute income is not an important predictor of functional dependency [85]. Moreover, higher self-rated financial adequacy was reported to indicate better physical health [84]. With respect to the level of education, Chinese older adults with lower education levels were correlated with higher possibility of ADL and IADL impairment, or mobility decline [56,60,61,65,81,83]. One study further indicated that an individual with a lower education level was more likely to have early-onset functional limitation [82].

Regarding family arrangement, risk factors of physical function impairment include being unmarried or widowed, having fewer household members, and having more children [23,29,56,83]. While most studies reported that being unmarried or widowed can predict physical function impairment [23,29,56], one study found that married individuals in Beijing showed higher levels of ADL limitations compared to unmarried ones [65]. A research based on the data generated from 3,159 Chinese older adults in the Greater Chicago Area mentioned that having fewer household members and

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Table 3: Risk and protective factors associated with physical function impairment in Chinese aging population.

Author, Year	Study Design	Population	Key Independent Variables	Covariates	Outcomes	Key Findings
Mainland China						
Yang Y, 2015 [67]	PS; 3 years	11,112 CLHLS participants; age ≥65, mean=83; F: 52.32%	Psychological resilience*	Sociodemographic characteristics, family support, and health.	ADL disability	Psychological resilience is protective against ADL disability OR=0.96 (0.94, 0.98).
Wang, 2015 [86]	PS; 5 years	1,562 routine check-up outpatients recruited in 2009; age ≥80, mean=85.2; gender ratio: NA	Polypharmacy	Age, type of medications and comorbidities	Falls, ADL disability	Falls: OR=1.18(1.10, 1.26), p <0.0001; ADL Disability: OR=1.16 (1.09, 1.24), p <0.0001.
Li, 2015 [95]	PS; 2 years	146 in patients with type 2 diabetes in Sichuan; age ≥60, median=80; F: 21.9%	Prefrailty, Frailty (FRAIL)	Age, gender, MMSE scores, BMI, duration of diabetes, and diabetes severity.	ADL, IADL disability	Prefrailty or frailty is associated with ADL disability. ADL: Prefrailty: OR=2.84 (1.07, 7.49); Frailty: OR=6.58 (1.66, 26.10) IADL: NS
Liang, 2014 [54]	PS; 9 years	7,845 CHNS participants; age ≥60. In 1997: age: mean (SD)=69.1(6.9); F: 54.3%. In 2006: age: mean (SD)=69.7 (7.0); F: 53.1%.	Age, gender, living location	Education, ever smoking, alcohol intake, obesity, hypertension, diabetes, myocardial infarction, and stroke.	ADL disability	ADL decline: Younger olds group (60-69)>older olds group (70+) (p=0.036); F > M (p=0.047); Rural >urban residents (p=0.019).
Zimmer, 2012 [78]	PS; 7 years	3,887 CLHLS participants; age ≥80, mean=83.4 for M, 83.9 for F; F: 50.3%	Age, prior nonagricultural occupation, rural residence, number of children, father's occupation	Demographic, socioeconomic factors	ADL limitations	Coefficient (log odds ratios): 1) Both genders: age (more favorable ADL limitation trajectories), prior nonagricultural occupation (less) 2) F: More: rural residence (-0.645), more children (-0.079), father works in agriculture (0.57). NS: education
Woo, 2009 [96]	PS; 4 years	4,000 older adults in Hong Kong; age ≥65; F: 50%	Musculoskeletal pain	Age, education, maximum lifetime income, socio-economic status ladders, medical history and use of statins	Physical function	1) M: Back pain-affecting ADL to reduced GS [MD=-0.16, 95% CI (-0.62, 0.31)]. Knee pain predisposed to reduced GS [MD=-0.55, 95% CI (-1.08, -0.01)], slower WS [MD=-0.04, 95% CI (-0.06, -0.02)], shorter SL [MD=-0.01, 95% CI (-0.02, -0.002)], lower level of physical activity [MD=-6.17, 95% CI (-11.95, -0.40)].2) 2) F: Back pain-affecting ADL to reduced GS [MD=-0.12, 95% CI (-0.50, 0.26)]. Knee pain predisposed to reduced GS [MD=-0.37, 95% CI (-0.76, 0.01)], slower WS [MD=-0.04, 95% CI (-0.06, -0.02)], shorter SL [MD=-0.01, 95% CI (-0.02, -0.01)], lower level of physical activity [MD=-1.07, 95% CI (-5.64, 3.49)].
Sun, 2009 [71]	PS; 4 years	2,490 CLHLS participants in 1998, 2000 and 2002; age ≥80; F: 57.4%	Age, rural/urban areas, activities, gender, smoking status	SDE	ADL difficulties	Higher increases in ADL difficulties: Being older (β=0.02, p<. 01), being female (β=0.16, p<0. 05) Less increase in ADL difficulties: Living in a rural area (β=–0. 26, p<0.01), non-smokers (β=–0.19, p<0.05), engaged in more activities (β=–0.04, p<0.01).
Kaneda, 2009 [72]	PS; 5 years	3,257 older adults in Beijing in 1992; 2,746 older adults in 1997; age ≥55, mean=64.1 for M, 63.8 for F; gender ratio: NA	Gender	Age; disease conditions; urban/rural residence	Functionally dependent	Functional dependence: F >M (12.4% vs. 7.0%, p <0.001).
Beydoun, 2005 [61]	PS; 3 years	976 CHNS participants in the 1997 and 2000 waves; age ≥55, mean (SD)=63.7(6.22); F: 48.1% in 1997	Socio-economic status (education, household income per capita)	Age, gender, urban-rural area of residence, living arrangements	Functional status decline	Lower SES vs. middle SES: OR=3.82 (2.15, 6.77); Lower SES vs. upper SES: OR=2.77(1.52, 5.03).

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Jiang, 2004 [85]	PS;	1,828 older adults in Beijing; age ≥55, mean (SD)=68.6(8.3); F: 47.3%	Depressive symptoms	Age, sex, education, economic, region, marital status, family relationship, intimate friends, chronic conditions	ADL, IADL disability	Depressed individuals had a higher risk of ADL or IADL disability. ADL: OR=2.20 (1.33, 3.62) IADL: OR=4.29 (2.08, 8.86)
Woo, 2000 [79]	PS; 3 years	2,032 older adults in Hong Kong; age ≥70, mean=80; F: 50.8%	Income	Age, sex	Functional dependency (the Barthel Index)	Absolute income is not an important factor in influencing dependency. Univariate analysis: <1000 HK dollars/ month: OR=1.80 (1.13, 2.85); Adjusted analysis: <1000 HK dollars/month: OR=1.12, NS
Welmer, 2014 [55]	CS	1,451 older adults in Xing Long Zhuang; age ≥60, mean (SD)=68.6(4.9); F: 59.0%	VRFs (abdominal obesity, physical inactivity, stroke, carotid atherosclerosis)	Demographics	Functional dependency (≥1 ADL or IADL limitation)	VRFs were associated with functional dependence. Hypertension: NS. High total cholesterol: NS. Abdominal obesity: OR=1.48(1.06, 2.06); Physical inactivity: OR=3.15 (1.83, 5.41); Stroke: OR=4.55 (2.84, 7.30); Carotid atherosclerosis: OR=1.49(1.04, 2.13); Peripheral artery disease: NS; Smoking: NS. Diabetes: NS Coronary heart disease: NS.
Yang, 2015 [87]	CS	616 older adults in Chengdu and Suining; age ≥60, mean (SD)=70.7 (6.8); F: 58.4%	Dynapenic Obesity	Age, gender, alcohol drinking status, smoking status, physical activity (minutes per day), and the chronic diseases mentioned previously.	Lower extremity function (20-meter gait speed test, balance test, and self-reported mobility disability)	1) Slow gait speed for nondynapenia/nonobesity, dynapenia-alone, obesity-alone: M: OR=0.55(0.27, 0.86), 0.78 (0.31, 0.96), and 0.86 (0.16, 0.95); F: OR=0.46 (0.27, 0.71), 0.80 (0.17, 0.93), and 0.73 (0.15, 0.91). 2) Mobility disability for nondynapenia/ nonobesity, dynapenia-alone, obesity-alone: M: OR=0.41 (0.26, 0.62), 0.61 (0.16, 0.85), 0.72 (0.28, 0.88); F: OR=0.37 (0.17, 0.81), 0.51 (0.27, 0.96), and 0.53 (0.26, 0.83).
Yang M,2014 [57]	CS	870 older adults in Dujiangyan; age ≥90, mean (SD)=93.5(3.2); F: 68.4%	Waist circumference (WC)	Age, education level, smoking, alcohol intake, physical activity, chronic conditions, and BMI.	ADL and IADL disability	Highest WC vs. lowest WC: ADL: M: OR=1.7(1.3, 4.5); F: OR=2.1(1.1, 4.0). IADL: M: OR=3.3 (1.3, 8.2); F: OR=2.0 (1.1, 3.9)
Yang, 2014 [58]	CS	616 older adults in Chengdu and Suining; age ≥60; F: 56.1%	Obesity, dynapenia, and dynapenic-obesity	Age, gender, alcohol intake status, smoking status, physical activity levels (min/d), and the chronic conditions mentioned previously	ADL/ IADL disability	OR (95% CI) for ADL disability for nondynapenia/nonobesity, dynapenia-alone, obesity-alone were 0.36 (0.1, 0.73), 0.51 (0.20, 0.78), and 0.40 (0.11, 0.61), respectively. OR (95% CI) for IADL disability for nondynapenia/nonobesity, dynapenia-alone, obesity-alone were 0.55 (0.20, 0.93), 0.82 (0.39, 0.98), and 0.61 (0.30, 0.91), respectively.
Meng, 2014 [77]	CS	101 older adults in Beijing; age ≥80; gender ratio: NA	Sarcopenia, Sarcopenic obesity, age	Height, total body skeletal muscle mass, total body fat percentage, thigh fat, relative appendicular skeletal muscle mass (RASM), percentage skeletal muscle index (SMI), and age.	Functional impairment	Correlations with GS: Thigh SMM: β=0.221, P=0.011; Total body fat: β=−0.216, P=0.002; Age: β=−0.524, P=0.000
Chien, 2014 [97]	CS	213 older adults; age ≥65; F: 64.3%	Poor sleep quality	Older age, ≥2 comorbidities, depression, functional capacity, and poor cognitive function.	Physical disability	Association between poor sleep and physical disability: OR=2.03(1.02, 4.05).
Xu, 2009 [59]	CS	875 older adults who were born at the Peking Union Medical College Hospital of China from 1921 to 1941; age ≥68; gender ratio: NA	Older maternal age at birth	Age, occupation, daily exercise, chronic disease	Physical function (higher ADL limitation)	Maternal age at birth >35 years were more likely to have ADL limitation in the geriatric period. OR=2.20(1.19, 4.08).

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Auyeung, 2008 [93]	CS	4,000 older adults; age ≥65; gender ratio: NA	Cognitive impairment (CSI-D >28.40)	Age, appendicular skeletal mass (ASM), the Physical Activity Scale for the Elderly (PASE) and other comorbidities.	Physical function decline	Cognitively impaired vs. non-impaired: Weaker GS(-2.60 kg, p <0.001 for M; -0.49 kg, p=0.011 for F); worse physical function tests (for M, 6-meter walk speed,-0.072 m/s, p <0.001, chair stand test, 0.80 s, p=0.045; for F, 6-meter walk speed, -0.049 m/s, p <0.001, chair stand test, 0.98 s, p <0.001)
Tang, 1999 [23]	CS	3,440 older adults in Beijing; age ≥60, mean (SD)=71.4(7.7); F: 50.4%	Geographic location, age, gender, marital status	NA	Functional disabilities	ADL-the plain rural had the highest disability rate, increasing with age. The disability rate is the lowest in all age groups of urban area, as compared with plain and mountain rural areas. The physical disability rate was lowest for the youngest group, grew by age, and reached to the first peak for the group (70-74). It decreased in the group of 75-79, and arose again in the oldest old (80). IADL- was lowest for the group of youngest old, grew by age, and reached to the peak for the oldest old. The group with the highest functional dependency rate had the lowest female proportion and married rate.
Zhang, 1998 [62]	CS	3,745 older adults in Shanghai; age ≥65.	Stroke, Parkinson's disease, dementia, diabetes and Emphysema	Age	ADL dependence	Important predictors of ADL dependence: Stroke, Parkinson's disease, dementia, diabetes and Emphysema.
Chen, 1995 [63]	CS	3,745 older adults in Shanghai; age ≥65.	Stroke, dementia, Parkinson's disease, diabetes, and emphysema	Age, gender, and education	Functional dependence, ADL performance	ADL performance was associated with dementia. Stroke, dementia, Parkinson's disease, diabetes, and emphysema were best predictors of functional dependence.
Hong Kong						
Auyeung, 2014 [73]	PS; 4 years	3,018 older adults in Hong Kong; age ≥65, mean (SD)=72.4(5.0) for M, 72.6(5.4) for F at recruitment; F: 50%	Gender, Race	Height	Age-associated decline of muscle mass, grip strength (GS) and grip speed.	The annualized decline in GS (-0.798 kg/year vs. -1.239 kg/year) and gait speed (-0.019 m/s/year vs. – 0.025 m/s/year) was faster for F than M. The mean appendicular skeletal mass (ASM) was 24.2 kg (8.0 kg/m^2) for M and 16.8 kg (6.5 kg/m2) for F among black and white, which were higher than Chinese older adults [19.1 kg (7.2 kg/m^2) for M and 13.8 kg (6.0 kg/m^2) for F]
Woo, 2009 [88]	PS; 5 years	3,153 older adults in Hong Kong; age ≥65; F: 50.3%	Sarcopenia (ASM)	Age, fat mass, presence or absence of malnutrition, dietary protein and Vitamin D intake, comorbidity, cognitive impairment	Physical limitations (ADL)	F: OR=4.6 (1.3, 15.8); M: OR=0.6 (0.1, 4.6), NS
Chu, 2006 [100]	PS; 1 year	1,419 older adults in Hong Kong; age ≥65, mean (SD)=73.1(6.2) at follow-up; F: 49.5%	Incident fall	BI was adjusted for age, Parkinson's disease, coronary heart disease, fear of falling, and GS. IADL was adjusted for age, Parkinson's disease, fear of falling, GDS, height, GS, and TMS. GS was adjusted for Parkinson's disease, visual acuity, and GS. TMS was adjusted for age, Parkinson's disease, previous hip fracture, and GS.	BI, IADL, gait speed, TMS	The relative risks (RR) of an incident fall as an independent predictor for decliners in the BI, IADL score, gait speed, and TMS were 2.4 (95% CI, 1.4, 4.0; p<0.01), 2.9 (95% CI, 1.7-5.2; p<0.001), 2.4 (95% CI, 1.5-3.8; p<0.001), and 4.6 (95% CI, 2.7-7.8; p<0.001), respectively.

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Woo, 1998 [69]	PS; 18 months	2,032 older adults in Hong Kong; age ≥70; F: 50.8%	Dementia, stroke, Parkinson's disease, fractures, asthma, diabetes	Age, sex	Function limitation	Diseases associated with severe functional limitation (Barthel Index<15): (p<0.0001) Dementia: OR=157.1(47.0, 528.0) Stroke: OR=19.3 (12.2, 30.4) Parkinson's disease: OR=14.2(4.9, 41.3) Fractures: OR=2.5(1.6, 3.8) Diseases associated with mild to moderate functional limitation (Barthel Index 15-19): (p<0.05) Stroke: OR=5.2(3.5, 7.7) Parkinson's disease: OR=5.2(1.9, 14.5) Asthma: OR=1.9(1.2, 3.0) Diabetes mellitus: OR=1.5(1.1, 2.2) Fractures: OR=1.7(1.3, 2.3) Dementia: OR=15.4(4.2, 56.3)
Ho, 1997 [81]	PS; 18 months	1,483 older adults in Hong Kong; age ≥70; F: 49.6%	Age, education, exercise, palpitation, body mass index, gait velocity, falls	Age, sex	Mobility decline	Increasing age: OR=1.4 (1.2, 1.6); no formal education: OR=1.9 (1.0, 3.9); no exercise: OR=2.1(1.4, 3.1); palpitation: OR=1.7(1.1, 2.8); body mass index < 20: OR=1.7(1.1, 2.6); slow gait velocity: OR=1.12(1.09, 1.16); experience of falls: OR=2.9(1.9, 4.5)
Woo, 2013 [80]	CS	1,324 older adults in Hong Kong; age ≥65; F: 54.3%	Income	Age, education	Physical function (ADL; physical performance)	Greater monthly disposable income (≥HK$500) or higher monthly income (≥HK$3,000) was associated with better health-related quality of life (physical component) for F.
Lee, 2011 [14]	CS	4,000 older adults in Hong Kong; age ≥65; F: 50.0%	1) Cognitive impairment (CSI-D), 2) high WHR, 3) diabetes, 4) stroke, 5) heart disease, 6) hypertension	Age, physical activity, ASM	Physical frailty (a composite score of GS, chair-stands, SL and 6MW)	M: 1) MD=-0.07(-2.05, -0.60) 2) MD=-0.09(-1.08, -0.40) 3) MD=-0.04(-0.90, -0.00) 4) MD=-0.08(-2.20, -9.81) 5) MD=-0.05(-1.05, -0.14) 6) MD=-0.05(-0.78, -0.12) F: 1) MD=-0.12(-1.54, -0.75) 2) MD=-0.11(-1.64, -0.76) 3) MD=-0.05(-1.15, -0.17) 4) MD=-0.05(-2.07, -0.20) 5) MD=-0.05(-1.20, -0.17) 6) MD=0.02(-0.20, 0.51), NS
Chau, 2011 [90]	CS	66,813 older adults in Hong Kong; age ≥65, mean=72.3 for M, 72.5 for F; F: 66.1%	Diabetes	Age, sex and education level	Function impairments (ADL, IADL)	Diabetes vs. without diabetes: OR=1.65 (1.51, 1.80).
Chou, 2008 [60]	CS	2,003 Hong Kong older adults in 1996, 2,180 in 2000, and 4,812 in 2004; age ≥60; F: 53.0% in 1996, 51.4% in 2000, 51.4% in 2004	Age, education, use of proxy, medical conditions (Arthritis, Heart disease, Tracheitis, Diabetes, Stroke, and Parkinson's disease)	NA	ADL limitation	Risk of ADL limitations increased as people aged (OR increased from 1.49 to 8.89). Elementary: OR=0.94(0.73,1.22), NS High school and above: OR=0.58(0.40,0.84) Use of proxy: OR=8.72(6.69, 11.38) Arthritis: OR=1.50(1.19, 1.90) Heart disease: OR=1.63(1.24, 2.15) Tracheitis: OR=2.30(1.64, 3.23) Diabetes: OR=1.59(1.21, 2.09) Stroke: OR=11.53(8.37, 15.88) Parkinson's disease: OR=8.33(3.98, 17.44)
Woo, 2007 [91]	CS	4,000 older adults in Hong Kong; age ≥65; F: 50%	BMI	Age, physical activity, and number of chronic diseases.	IADL impairments, walking performance	Having 0 IADL impairment: BMI ≥25: 67.74%-70.23%; BMI<25: 70.09%-76.92%. Having 1-2 IADL impairments: BMI ≥25: 24.19%-26.16%; BMI<25: 18.9%-24.3%. Having 3-5 IADL impairments: BMI ≥25: 3.62%-8.06%; BMI<25: 3.13%-5.61%. Walking speed (m/s), mean (SE): BMI ≥30: 0.9(0.02) 30>BMI ≥25: 1.00(0.01) BMI<25: 1.02(0.01)-1.04(0.01)

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Tai Wan						
Zimmer, 2014 [82]	PS; 11 years	5,131 older adults in Taiwan, 3,024 for follow-up; age ≥50, mean (SD)=63.4(9.0) for first wave in 1996; F: 47.0%	Female, education, age	Mainlander, married, urban residence,	Functional limitation	1) Being females and have least education are more likely to have early-onset functional limitation. Early vs. late onset: F: 2.020 Education: -0.149 2) Education is less important for F than M in predicting trajectory. 3) Functional limitation increase with age.
Zimmer, 1998 [83]	PS; 4 years	4,049 older adults in Taiwan; age ≥60; F: 40.0%	Education, age, married	NA	Functional limitation (ADL or IADL)	1) Higher education and being married are associated with a lower incidence of functional limitation for those have no limitation before. 2) Older age is more likely to have functional limitation. Marginal effects (independent vs. limited in follow-up): Education: 0.0076 vs. -0.0067 Age: -0.0138 vs. 0.0079 Married: 0.1150 vs. -0.0352
Huang, 2015 [94]	CS	731 older adults in Taiwan; age: mean (SD)=73.4 (5.4); F: 53.8%	Global cognitive impairment (MMSE)	Age, gender	Low physical performance (6MW); low muscle strength (by dynamometer)	Low physical performance: OR=2.31, p=0.003; Low muscle strength: OR=2.59, p=0.011
Wang, 2012 [74]	CS	781 older adults in Taiwan; mean age=79.35; F: 39.4%	Gender, healthcare unit size, history of neurological, psychiatric/ mood, and pulmonary diseases or infection	NA	Chewing and swallowing problems (PCS)	Being female (OR=1.51, p=0.019); lived in smaller long-term care facilities (bed count <50) (OR=4.18, p<0.001); a history of neurological disease (OR=2.83, P<0.001); a history of psychiatric/mood disease (OR=1.74, P<0.036); a history of pulmonary disease (OR=2.08, P<0.008); and with infections (OR=2.07, P<0.001).
Lan, 2009 [101]	CS	10,596 older adults in Taiwan; age ≥65, mean (SD)=78.1(7.5); F: 62.4%	Home environmental hazards	Demographic, social, and health factors	Physical function	Two common home hazards for older adults: No grab bars (79.6-85.1%) and no protections against slip (81.9-92.8%) in the bathroom.
Wu, 2002 [98]	CS	39 older adults in Beijing; age≥55; F: 61.5%	Tai Chi (n=20, had practiced Tai Chi for a minimum of 3 years)	Age, gender	Knee extensor strength	Tai Chi vs. control: Higher knee extensor strength (p<0.013).
Wong, 2001 [99]	CS	39 older adults in Taiwan; age ≥66; F: 69.2%	Tai Chi (n=25, practiced Tai Chi for 2 to 35 years. Divided into 2 groups based on years of practice Tai Chi: group I< 3 yr, group II ≥3 yr.)	NA	Improvements in static postural stability test (SV, ECSS, SVSS)	1) Ankle strategy (mean difference): SV: Group I vs. control: 3.20±1.20, p=0.035 Group II vs. control: 1.99±0.96, NS ECSS: Group I vs. control: 9.15±3.91, NS Group II vs. control: 8.93±3.15, p=0.021 SVSS: Group I vs. control: 16.38±5.11, p=0.008 Group II vs. control: 15.96±4.11, p=0.001 2) Maximal stability (mean difference): ECSS: Group I vs. control: 16.87±5.62, p=0.014 Group II vs. control: 12.21±4.52, p=0.031 SVSS: Group I vs. control: 21.80±5.15, p=0.0004 Group II vs. control: 19.74±4.14, p=0.0001
Liu, 1997 [92]	CS	1,313 older adults in a rural community of Kinmen, Taiwan; age ≥65, mean (SD)=73.9(6.8); F: 55.5%	Depressive disorders: diagnosed based on the DSM-III-R criteria.	NA	ADL	ADL: from 1 (no significant disability) to 5(severe disability). ADL for major depression: 1.6+/-1.0 ADL for other depression: 1.2+/-0.6 ADL for not depressed: 1.0+/-0.4 (F=56.80, p<0.001).
Singapore						

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Wong, 2003 [75]	CS	121 older adults in Singapore; age ≥50, mean (SD)=62.6(8.0); F: 62.8%	Gender; habitual walking	Age, health status, and social factors	Physical performance after habitual walking	M performed better in GS, at B=10.38 (ml/kg)/min [95% CI (7.00-13.78), p<0.001), had a higher VO2 max, B=9.52 (ml/kg)/min [95% CI (6.26-12.78), p<0.001), and lower body fat composition, B=-6.40% [95% CI (-7: 89 to -4: 90), p<0.001] than F. Every 1 minute per day increase in habitual walking increases VO2max by 0.096 (ml/kg)/min [95% CI (0.027-0.165), p=0.007).
North America						
Dong, 2014 [56]	CS	3,159 older adults in Chicago, USA; age: 60-105, mean (SD)=72.8(8.3); F: 58.9%	Age, gender, education, marital status, living arrangement, number of children, years in the US, years in the community, health status	Medical comorbidities, chronic conditions, nutrition, lifestyle habits	Physical function	For self-reported measure: Older age (r=0.48), female (r=0.10), lower education level (r=-0.17), being unmarried (r=-0.20), living with fewer household members (r=-0.18), having more children (r=0.21), having been in the United States for more years (r=0.18), having been in the community for more years (r=0.28), worsened quality of life (r=-0.06), and worsened health over the last year (r=-0.13), were correlated with ADL/IADL impairment. Significant correlations with better physical performance test: Younger age (r=−0.46), being male (r=−0.12), higher education (r=0.26), married (r=0.24), more household members (r=0.20), fewer children (r=−0.24), in the U.S. for fewer years (r=−0.24), in the community for fewer years (r=−0.15), better self-reported health status (r=0.26), better quality of life (r=0.11), and improved health over the last year (r=0.16)
Chau, 2011 [84]	CS	2,272 Chinese older adults in Canada; age ≥55, mean (SD)=69.8(8.7); F: 55.8%	Size of Chinese community; gender; self-rated financial adequacy	Age, gender, marital status, living arrangement, education, financial adequacy, English competency, country of origin, social support, service barriers.	Physical health (SF-36 PCS)	Better physical health (Standardized coefficients β): Residing in communities with a small Chinese population: β=-0.08. Male: β=0.12 Higher financial adequacy: β=0.13
Cous-tasse, 2008 [29]	CS	738 Asian Americans (190 Chinese) in the National Health Interview Survey; age ≥65; gender ratio: NA	Gender, marital status, age	NA	ADL and IADL disability	Being female (17.1% vs. 7.1%), not married (20.6% vs. 8.2%), and older (25.3% vs. 4.7%) was associated with higher ADL and IADL disability (p<0.05).
Lai, 2007 [102]	CS	2,272 older Chinese in Canada; age: 55-101, mean=69.8; F: 55.8%	1) Chinese cultural values (11-item self-developed scale); 2) Chinese health beliefs (12-item self-developed scale)	Age, gender, married, living alone, education, English competency, financial adequacy, income, country of origin, length of residence in Canada, religion	Physical health (PCS); ADL limitations; IADL limitations	Regression coefficient: Physical health: 1)-0.05(p<0.05); 2)-0.06(p<0.01) ADL limitations: 1) 0.01; 2) 0.04 IADL limitations: 1) 0.03; 2) 0.07(p<0.01) Chinese health beliefs significantly predict physical health and IADL limitation.
Cross Cities						
Zimmer, 2007 [65]	PS; 3 years	Beijing: 2,458 older adults in 1994 and 2,043 in 1997; age ≥60, mean=68.2 in 1994, 68.8 in 1997; F: 50.1% in 1994 and 51.1% in 1997. Taiwan: 3,584 older adults in 1996 and 3,591 in 1999; age ≥60, mean=69.5 in 1996, 69.8 in 1999; F: 45.2% in 1996 and 46.9% in 1999.	Age, female, married, education	Age, female, married, education (adjusted for compositional effects)	ADL limitation; IADL limitation; Nagi limitation	1) ADL limitation (OR-Beijing vs. Taiwan): Age: 1.11 vs. 1.10 F: NS Married: 1.42 vs. 0.92 (NS) Secondary or higher education: 0.61 (NS) vs. 0.49 2) IADL limitation (OR-Beijing vs. Taiwan): Age: 1.10 vs. 1.13 F:1.37 vs. 2.28 Primary education: 0.67 vs. 0.48 Secondary or higher education: 0.48 vs. 0.26 3) Nagi Limitation (OR-Beijing vs. Taiwan): Age: 1.10 vs. 1.10 F: 1.41 vs. 2.60 Married: NS Primary education: 0.63 vs. 0.69 Secondary or higher education: 0.44 vs. 0.47

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Feng, 2011 [64]	CS	4,639 older adults in Shanghai, 2,397 older adults in Singapore; age ≥55, mean=68.3 in Shanghai, 65.6 in Singapore; F: 56.9%	1) Number of chronic diseases, 2) self-rated health status, 3) cognitive function (MMSE, higher score, better cog), 4) environment (Singapore vs. Shanghai)	Age, gender, number of chronic diseases, self-rated health status, and MMSE total score.	Functional disability (ADL)	Physical health or cognitive function contributed to ADL-based functional disability. 1) OR=1.35(1.22, 1.50); 2) OR=2.85(2.36, 3.43); 3) OR=0.89(0.85, 0.94); 4) OR=0.68(0.48, 0.96)

6 MW: 6-Minute Walk Test; ADL: Activities of Daily Living; ASM: Appendicular muscle mass; BI: Barthel Index; BMI: Body mass index; CHNS: China Health and Nutrition Survey; CLHLS: Chinese Longitudinal Healthy Longevity Survey; CS: Cross Sectional Study; CSI-D: Community Screening Instrument of Dementia; ECSS: Eyes Closed And Sway-Referenced Support; SVSS: Sway-Reference Division And Support; F: Female; FRAIL: 5-item FRAIL Scale; GDS: Geriatric Depression Scale; GS: Grip Strength; IADL: Instrumental Activities of Daily Living; M: Male; MD: Mean Difference; MMSE: Mini-Mental State Examination; Nagi: Nagi Index Of Basic Physical Activities; NS: Not Significant; OR: Odds Ratio; PCS: Physical Component Summary of a Chinese Version of the Medical Outcome Study Short Form-36; PS: Prospective Study; r: Correlation; SDE: Sociodemographic Variables; SF-36 PCS: 36-item Short from Physical Component Summary; SL: Step Length; SMM: Skeletal Muscle Mass; SV: Sway-Referenced Vision And Fixed Support; TMS: Total Mobility Score in Tinetti Balance and Gait Evaluation; VRFs: Vascular Risk Factors; WHR: Waist Hip Ratio; WS: Walking Speed.
Psychological resilience was measured by a 5-item scale: 1) Do you feel the older you get, the more useless you are? 2) Do you always look on the bright side of things? 3) Do you often feel fearful or anxious? 4) Do you often feel lonely and isolated? 5) Can you make your own decisions concerning your personal affairs?

more children has been linked with ADL or IADL impairment [56].

With respect to location and immigration status, risk factors include living in a rural area, larger Chinese community, and living in the U.S. for more years [23,54,56,71,78,84]. Three studies from Mainland China indicated the difference of functional disabilities between rural and urban residents [23,54,78]. Compared with respondents living in urban areas, older adults living in rural areas had higher disability rates for all age groups [23,54]. One study found that rural residence was associated with ADL limitation among female participants [78]. In contrast, a study indicated that living in a rural area could lead to a less rapid increase in ADL difficulties [71]. Additionally, one study among 2,272 Chinese Canadian population reported that residing in communities with a smaller Chinese population was associated with better physical health [84]. In terms of immigration status, results based on a community-dwelling population of U.S. Chinese older adults indicated that having been in the United States and living in the community longer were associated with ADL or IADL impairment [56].

Health conditions

In terms of health conditions, disease, especially chronic conditions, is a major risk factor associated with physical function impairment. Relatedly, polypharmacy is another risk factor associated with physical function impairment [86]. Most commonly reported diseases include obesity [55,58,87], sarcopenia [77,88,89], stroke [14,55,62,63,69], diabetes [14,62,63,69,90], arthritis [60], asthma [69], heart disease [14], hypertension [14], tracheitis [60], and emphysema (Table 3) [62,63]. Regarding obesity as an example, several studies have reported that older adults with obesity not only had generally worse physical function but also had a greater risk of ADL or IADL disability [55,58,87]. High values of BMI or waist circumference are also used to predict poor physical function performance [57,91]. Dynapenia or dynapenic-obesity were also positively associated with an increased risk of slow gait speed, mobility disability, or ADL or IADL limitations [58,87]. Moreover, worsened health over the last year was correlated with older Chinese Americans' ADL or IADL impairment [56]. However, only one cross-city study conducted in Shanghai and Singapore reported that the number of chronic diseases was associated with ADL measured functional disability [64].

Changes in the psychological and psychiatric status also play a pivotal role in describing the occurrence of physical function impairment. Common risk factors include helplessness or depressive symptoms [85,92], a history of neurological disease [74], psychiatric or mood disease [74], Parkinson's disease [62,63,69], dementia [62,63,69], and cognitive impairment [14,64,93,94]. For example, individuals who experience helplessness or depressive disorders were reported to have ADL limitations, IADL limitations, or other physical disability [85,92]. On the other hand, psychological resilience was regarded as an important protective factor that can fight against ADL disability [67].

Additionally, other risk factors related to health conditions include frailty [95], high waist circumference [57], pain [96], and poor sleep quality [97]. Last, results generated from a sample with 875 older adults born at the Peking Union Medical College Hospital of China form 1921 to 1941 showed that older maternal age at birth (35 or above) could make children at a higher risk of ADL limitation in older age [59].

Health behaviors

Existing studies conducted among Chinese communities showed a better physical function if engaged in more physical activities such as Tai Chi [98,99], habitual walking [75], or being non-smokers or quitting smoking (Table 3) [71]. For example, a study contains 39 older adults in Beijing reported that those who practiced Tai Chi has higher knee extensor strength compared to those who do not ($p<0.013$). Another study in Singapore indicated that older adults with self-reported higher levels of habitual walking are more likely to have better performance in peak oxygen consumption (VO2 max), one measure to examine one's physical performance and fitness ($p=0.007$) [75].

Other factors

In addition to those common risk and protective factors list above, there are other factors associated with physical function impairment, such as falls [81,100,101], home environmental hazards

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Table 4: Consequences of physical function impairment in Chinese aging population

Author, Year	Study Design	Population	Predictor	Outcomes	Covariates	Key Findings
Mainland China						
Zou, 2015 [122]	PS; 49 months	825 older adults in Dujiangyan, China; age ≥90, mean (SD)=93.6(3.4) for baseline; F: 68.0%	ADL or IADL disabilities	Mortality	NA	ADL: HR=1.07(1.03, 1.11), IADL: HR=1.03(1.01, 1.04). In adjusted models, no significant results. ADL: HR=1.01(0.95, 1.07), NS IADL: HR=1.02(0.99, 1.04), NS
Feng, 2010 [123]	PS; 3 years	16,020 CLHLS participants; age ≥65, mean (SD)=72.5(6.1) for baseline; F: 57.4%	ADL, PP	Mortality	Sociodemographic, living situation, healthcare access, social support, health status, life style	Without any limitations in ADL or PP had lower mortality risk than those with limitations. Limitation in PP, no ADL: HR=1.31(1.20, 1.42); Limitation in ADL, no PP: HR=1.39(1.23, 1.59); Limitation in ADL and PP: HR=1.88(1.72, 2.05)
Zhang, 2015 [119]	CS	8,399 older adults in Shanghai; age: ≥60, mean (SD)=72.1 (9.2); F: 53.26%	IADL disabilities	Attempted suicide	Age, gender, living arrangements and primary caregiver type.	Associated IADL disabilities with attempted suicide (p<0.05): Shopping: OR=3.01(1.56, 5.81); Preparing meals: OR=4.12(2.12, 8.00); Housekeeping: OR=2.48(1.01, 6.06); Doing laundry: OR=2.82(1.09, 7.35); Using transport: OR=3.10(1.36, 6.99); And medical care: OR=4.41(2.10, 9.17). Having ≥1 IADL disabilities was related to a threefold increase in attempted suicide rate; having ≥5 IADL disabilities was related to a fivefold increase in attempted suicide rate.
Cao, 2014 [89]	CS	230 older adults in Chengdu; age ≥65; F: 62.2%	Physical performance, grip strength	Sarcopenia	Age, gender	Poor physical performance and GS were associated with sarcopenia (SarC-F ≥4) (P<0.005).
Zhang, 2014 [116]	CS	976 older adults in Tianjin; age ≥60, mean (SD)=67.6(6.0); F: 55.5%	Poor lower extremity function (GS, TUGT, WS)	Pre-diabetes (126 mg/dL≥FPG≥100 mg/dL), diabetes (self-reported physician's diagnosis, or a FPG≥ 126 mg/dL)	Age, BMI, hypertension, hyperlipidemia, stroke, coronary heart disease, kidney disease, ≥2 chronic diseases, being famer, educational, smoking and drinking habits, falls, physical activity, creatinine, blood urea nitrogen, total cholesterol, triglyceride	1) M: Poor TUGT and decreased WS had higher odds of pre-diabetes (p for trend=0.007; 0.008) and diabetes (p for trend=0.012; 0.014). 2) F: Poor TUGT and decreased WS had higher odds of diabetes (p for trend=0.020; 0.034), but not for pre-diabetes. 3) For both genders: GS and pre-diabetes/diabetes: NS.
Zhang 2011 [103]	CS	2,002 older adults in Beijing; age ≥60, mean (SD)=71.6(6.7); F: 49.5%	Poor ADL, poor physical health	Depression	NA	Poor physical health [OR=17.69(10.68, 29.28) for poor, OR=3.86(2.34, 6.38) for fair, and 1 or good] and functional decline assessed by ADL [OR=5.79(4.16, 8.05) for poor, OR=2.48(1.73, 3.56) for fair, and 1 for good] are significantly associated with depression in older adults (p<0.001).
Hong Kong and Tai Wan						
Auyeung, 2011 [110]	PS; 4 years	2,737 older adults in Hong Kong; age ≥65, mean (SD)=71.6(4.7) at baseline; F: 44.7%	Physical frailty (HS, chair-stand, WS, SL)	Cognitive decline (CSI-D)	Age, education, baseline MMSE score	Physical frailty is associated with cognitive decline. (Adjusted difference of MMSE score) 1) M: HS: 0.23(0.09, 0.38) Chair-stand: -0.23(-0.37, -0.09) WS: 0.14(-0.01, 0.29), NS SL: 0.16(0.01, 0.31) 2) F: HS: 0.30(0.04, 0.35) Chair-stand: -0.06(-0.21, 0.10), NS WS: 0.055(-0.11, 0.22), NS SL: 0.020(-0.14, 0.18), NS

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Lee, 2011 [14]	PS; 6 year	4,000 older adults in Hong Kong; age ≥65, mean=72.3 for M and 72.5 for F at baseline; F: 50.0%	Physical frailty (a composite score of GS, chair-stands, SL and 6MW)	6-year mortality	Age, cognitive function, metabolic and atherosclerotic factors	1) M: HR=1.10(1.06, 1.14), p<0.001; 2) F: HR=1.06(1.01, 1.12), p=0.032
Woo, 2009 [115]	PS; 2 years	3,890 older adults in Hong Kong; age ≥65; F: 50.1%	Functional limitation (IADL)	Recurrent falls	NA	M vs. F: 1-2 IADL limitations: OR=2.21(1.50, 3.25) vs. 1.56(1.17, 2.10); 3-5 IADL limitations: OR=2.66(1.08, 6.52) vs. 1.57(0.90, 2.76), NS.
Zimmer, 2005 [124]	PS; 10 years	4, 049 older adults in Taiwan; age ≥60; F: 42.9%	Self-reported functional status (13-item, from 0-no difficulty to 3 cannot perform the task)	Mortality	Age, gender, married, mainlander, education, health behaviors, health conditions	Individuals with functional limitations at a prior survey wave were more likely to die than those with no limitation. Higher degree of limitation is associated with higher risk of dying. Functional status: positive coefficients No problem: ref First quintile: 0.336 Second: 0.172, NS Third: 0.518 Fourth: 0.654 Fifth: 1.189
Woo, 1999 [118]	PS; 3 years	2,032 older adults in Hong Kong; age ≥70; F: 52.3%	WS, SL	Dependency, mortality, and institutionalization	NA	Reduced WS and SL were associated with increased risk of dependency, mortality, and institutionalization.
Wu, 2015 [111]	CS	1,686 older adults in Taiwan; age: 50-89, mean (SD)=63.4(8.9); F: 52.4%	Physical frailty (CHS)	Cognitive impairments (MMSE, CVVLT, BNT, VFT, CFT, DB)	Age, gender, education, comorbidity	Frail individuals were 1.79 times more likely to have ≥1 cognitive domain impairments, OR=1.79(1.05, 3.04).
Chen, 2015 [104]	CS	400 older adults in Hong Kong; age ≥60, mean (SD)=80.2(7.5); F: 56.5%	Physical function (the Barthel index, higher score, higher level of functioning)	Depressive symptoms (GDS)	Age, gender, fall history, income, married, education, support network	Coefficient β=-0.007, p<0.001
Zheng, 2014 [105]	CS	1,429 older adults in Hong Kong; age ≥60, mean (SD)=77.6(8.5); F: 40.0%	Functional disability (combined score of ADL, IADL, and CRCA mobility)	Depression (GDS)	Gender, age, education, marital status, income	Positively associated with depression, Coefficient β=0.087, p<0.001
Lee, 2014 [12]	CS	24 psychiatric out patients in Taiwan. Inclusion criteria: 1) 65+; 2) No severe cognitive deficit; 3) Out patients in the psychiatric clinics at the selected hospitals; and 4) self-reported first episode of suicidal ideation within the previous year age: mean (SD)=72.1(6.2); F: 70.8%	Illness and physical discomfort	Suicide ideation	NA	Reasons for suicidal ideation: Illness and physical discomfort (58.3%)
Chan, 2011 [120]	CS	3,596 older adults in Taiwan; age ≥65, mean (SD)=73.5(5.8); F: 48.7%	Disability	Suicide ideation	NA	OR=2.87 95% (2.00, 4.13).
Chu, 2011 [113]	CS	371 older men living in a veteran home in southern Taiwan; age: 67-99, mean (SD)=82.1(5.1); gender ratio: NA	Poor ADL	Fear of falling	NA	Poor ADL was risk factors for fear of falling OR=2.48(1.08, 5.71), p=0.033.
Chen, 2008 [114]	CS	585 residents in a veteran care home in northern Taiwan; age ≥65, mean (SD)=80.9(5.4); gender ratio: NA	Poor physical function (MDS RUG ADL score)	Falls	NA	Fallers vs. non-fallers: Poorer functional status with MDS RUG ADL score (5.0+/-2.3 vs. 4.3+/-1.6; p=0.044). Higher RUG ADL score was a risk factor for falls [OR=1.18(1.08, 1.37), p=0.017].
Chi, 2005 [107]	CS	917 older adults in Hong Kong; age ≥60; F: 51.2%	ADL, IADL	Depression (GDS)	Sociodemographic variables	Poorer ADL was associated with a higher risk of depression. Severity of ADL impairment: OR=1.21(1.05, 1.41) IADL: NS

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Yip, 2003 [121]	CS	917 older adults in Hong Kong; age: 60-98, mean=71; F: 51.5%	Self-rated poor physical health, vision problems, hearing problems, having problems with ADLs and IADLs	Suicidal ideation	NA	Risk factors to suicidal ideation: Vision problem: OR=1.66(1.18, 2.33), p=0.003; Hearing problem: OR=1.54(1.11, 2.14), p=0.009; PSMS: OR=1.21(1.03, 1.42), p=0.018.
Woo, 1995 [117]	CS	2,011 older adults in Hong Kong; age ≥70; F: 50.8%	Poor functional ability (ADL, the Barthel indec)	Low anthropometric indices (BMI, AMC, CAMA, FFM, TBF)	NA	Anthropometric indices were lower in subjects with poorer functional ability. ADL score 15-20 vs. <15 (mean): BMI: 21.5-22.0 vs. 19.8-20.7; AMC: 19.2-21.2 vs. 18.0-20.0; CAMA: 23.5- 26.1 vs. 19.9-22.3; FFM: 33.0- 40.9 vs. 32.8- 37.0; TBF: 14.2-16.2 vs. 10.8-12.0.
Woo, 1994 [108]	CS	1,611 older adults in Hong Kong; age ≥70; F: 45.6%	Functional disability (the Barthel Index <15)	Depressive symptoms (GDS)	NA	Functional disability (Barthel Index <15) is associated with depressive symptoms. Barthel index (coefficient; SE; OR; 95% CI): 15-19: 0.45; 0.26; 1.57; 0.95-2.60 <15: 2.72; 0.70; 15.2; 3.89-59.5.
Woo, 1994 [112]	CS	2,011 older adults in Hong Kong; age ≥70; F: 50.9%	Functional disability (ADL, the Barthel index)	Cognitive impairment (CAPE ≤7	NA	Functional disability is one associated factor of cognitive impairment. ADL score: 20: reference 15-19: OR=2.23(1.65, 3.02); 1-14: OR=9.21(5.75, 14.75)
North American						
Lai, 2005 [106]	CS	98 Taiwanese immigrants in Canada; age ≥55, mean (SD)=67.9(8.4); F: 42.9%	Poor physical health (ADL, IADL, PCS)	Depressive symptoms (GDS)	Attitude towards aging, married, financial adequacy, income, Chinese health beliefs, and service barriers	Spearmen's correlation: r=-0.35(p<0.001); β=-0.04 (p<0.001); SE=0.01; R square=0.33; Adjusted R square=0.31;
Lai 2004 [109]	CS	444 Chinese immigrants in Canada; age ≥65, mean (SD)=73.8(6.8); F: 53.8%	ADL. IADL, poor physical health (PCS)	Depressive symptoms (GDS)	NA	1) ADL dependency, IADL dependency, and PCS were associated with more depressive symptoms. ADL: rs=0.13 IADL: rs=0.21 PCS: rs=-0.34 2) PCS tended to have more depressive symptoms. PCS: β=-0.01, SE=0.00

6MW: 6-Minute Walk Test; ADL: Activities of Daily Living; AMC: Arm Muscle Circumference; BMI: Body Mass Index; BNT: the Boston Naming Test; CAMA: Corrected Arm Muscle Area; CAPE: the Clifton Assessment Procedure for the Elderly; CFT: the Taylor Complex Figure Test; CHS: Cardiovascular Health Study; CLHLS: Chinese Longitudinal Healthy Longevity Survey; CRCA: China Research Center on Aging; CS: Cross Sectional Study; CSI-D: Community Screening Instrument of Dementia; CVVLT: the delay free recall in the Chinese Version Verbal Learning Test; DB: the Digital Backward; HR: Hazard Ratio; F: Female; FFM: Fat-Free Mass; FPG: Fasting Plasma Glucose Level; GDS: the Geriatric Depression Scale; GS: Grip Strength; HS: Handgrip Strength; IADL: Instrumental Activities of Daily Living; MMSE: Mini-Mental State Examination; NS: Not Significant; OR: Odds Ratio; PCS: the Physical Component Summary of a Chinese version of the Medical Outcome Study Short Form-36; PP: Physical Performance Tests (chair standing, lifting a book from floor, turning 360 degrees); PS: Prospective Study; PSMS: Physical Self-Maintenance Scale; r: correlation; RR: Relative Risk; r: Correlation; SL: Step Length; TBF: Total Body Fat; TUG: Timed Up & Go; TUGT: Timed Up and Go Test; VFT: the Category (animal) Verbal Fluency Test; WS: Walking Speed.

[101], ethnicity [73], Chinese health beliefs [102], healthcare unit size [74], quality of life [56], and agricultural occupation (Table 3) [78].

According to our review, falls and home environmental hazards are common risk factors of physical function impairment among the aging population [81,100,101]. A study conducted among 1,419 community-dwelling Chinese older adults in Hong Kong revealed that an incident fall could lead to lower scores of the Barthel Index, the Total Mobility Score in Tinetti Balance and Gait Evaluation, IADL, and slower gait speed ($p<0.001$) [100]. Home environmental hazards can also put older adults at a high risk of falls or other physical injuries and therefore have a negative impact on their physical function. For older adults, two common home hazards were lack of grab bars and no protections against slipping in the bathroom [101].

Auyeung et al. have reported community-dwelling Chinese older adults in Hong Kong have lower mean appendicular skeletal mass scores compared to black and white counterparts, suggesting ethnicity may be an important indicator and contributor to physical function differences [73]. Out of all the papers included in this review, there is only one study conducted in 2,272 Canadian Chinese population which quantified and analyzed Chinese culture, finding Chinese health beliefs are associated with physical health and IADL limitations [102].

Consequences

Physical function impairment has multiple serious consequences among Chinese older adults, such as depression or depressive symptoms [11,103-109], cognitive impairment [110-112], fear

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of falling [113], falls [114,115], sarcopenia [89], pre-diabetes and diabetes [116], low anthropometric indices [117], a risking risk of dependency [118], and institutionalization [118], attempted suicide or suicidal ideation [119-121], and mortality (Table 4) [14,118,122-124].

In Mainland China, studies showed that physical function impairment was associated with depression or higher depressive symptoms, while better physical function was positively associated with psychological well-being [11,103-109]. In addition, a history of falls is one of the most recognizable risk factors of physical function impairment, and physical function impairment in turn can result in falls [114,115]. Poor ADL performance can also make older adults fear falling, which has been shown among Chinese older adults [113]. Furthermore, reduced walking speed and stride length may be a predictor of older adults' rising risk of dependency and institutionalization [118].

Suicide or suicidal ideation is another consequence associated with physical function impairment [119-121]. For example, a study conducted among 8,399 Chinese older adults aged 60 or above in Shanghai reported that IADL disabilities were associated with attempted suicide. The researchers also demonstrated that more IADL disabilities is related to an increase in suicide attempts [119]. Moreover, impairment in physical function can lead to severe consequences among Chinese aging population such as a higher risk of mortality [14,118,122-124].

Discussion

Physical function impairment is prevalent among the global Chinese population. Additionally, most studies reported an increasing number of physical function impairment over time among Chinese older adults. Common risk and protective factors of physical function impairment can be described into three main dimensions including socio-demographic characteristics, health conditions, and health behaviors. Impairments in physical function can lead to adverse health consequences, both physical and psychological. These findings indicate potential healthcare and caregiving issues for Chinese older adults with physical function impairment and have important implications for future research and policy.

Prevalence/Incidence: The prevalence of physical function impairment varies across different regional and cultural groups; however, there are limited studies comparing the prevalence rates between Chinese and other racial groups. Lack of a standardized evaluation makes it difficult to compare prevalence rates across multiple study groups. According to our review, only two studies conducted in North America did the comparisons of physical function impairment among different racial groups. One reported that the Chinese subgroup has the highest ADL or IADL disability prevalence compared to other Asian Americans [29], while the other reported the Chinese subgroup has the lowest disability prevalence compared to other Asian Americans [125]. The results are contradictory and further research comparing prevalence across different racial groups is needed.

Another study conducted among U.S. Chinese older adults in the Greater Chicago Area reported a high IADL impairment prevalence of 50.2% [56], which indicates Chinese immigrants may have a higher risk of physical function impairment due to unique factors associated with immigration status, such as acculturation [49,126]. Linguistic and cultural barriers can result in poor access to and use of healthcare services [127,128] and negatively influence Asian immigrants on their physical and mental health [128,129], which may lead to a high prevalence of physical function impairment. Although most studies reported increasing numbers of physical function impairment over time, this trend is not uniformly present in all research. There are three articles which reported a decline of ADL or IADL disability among Chinese aging population [53,70,130]. For example, a 10-year study examining the trends of ADL and IADL disability in a cohort of Shanghai reported that older adults in 2003, 2005, and 2008 were less likely to be IADL disabled compared to those in 1998, but no significant changes were found in ADL [130]. More longitudinal studies are needed to explore the trends of physical function impairment among Chinese older adults over time.

Risk and protective factors: Due to the diversity of studies with respect to setting, population, and research methodologies, a variety of risk factors have been identified to be associated with physical function impairment among Chinese older adults. According to our review, the most common risk factors of physical function impairment in Chinese aging populations include older age, female gender, lower education levels, lower socioeconomic status, unmarried, having fewer household members, rural residents, chronic diseases, depression or depressive symptoms, cognitive impairment, and incident falls, which resonated with prior studies conducted in other geographic areas with non-Chinese individuals [19,86,131-136]. However, one longitudinal study reported an increasing disability trend over time experienced by male rather than female [70]. The association between female gender and physical function impairment deserves further exploration. Research has also established among other racial and ethnic groups that smoking, alcohol abuse, an unhealthy diet associated obesity, and lack of exercise could cause worsening in physical performance [81,133,134,137,138]; similarly, our review revealed that healthy lifestyle behaviors may lead to better physical functioning among Chinese older adults, such as engaged in more physical activities, practicing Tai Chi, habitual walking, and being non-smokers or quitting smoking. Notably, there is still limited knowledge regarding other factors like ethnic or racial differences. For example, although one prior study reported that Asian older adults may experience poorer physical function than other ethnic groups [73], but still, very little is known about the ethnic difference in physical function impairment between Chinese and other aging populations.

Consequences: Depression or depressive symptoms, cognitive impairment, fear of falling, falls, sarcopenia, attempted suicide or suicidal ideation, and mortality are established health consequences associated with physical function impairment for Chinese older adults. These findings were consistent with research conducted among other racial groups [9,13,39-48]. Notably, depression or depressive symptoms, falls, sarcopenia, and cognitive impairment were reported not only as risk factors but also as outcomes of physical function impairment. For example, falls may directly lead to physical function impairment, and also may confine older adults to homes and limit their activity due to fear of falls, which may further accelerate functional loss and put older adults at a higher risk of recurrent falls.

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The relationship between these factors and physical impairment warrants further investigation among the Chinese aging population. Additionally, there are limited studies examining other health consequences associated with physical function impairment among Chinese aging population, which has been reported in other cohorts, such as self-neglect [139], and pre-diabetes or diabetes [116].

Previous studies have highlighted the impact of physical function impairment on the occurrence of mental health issues such as depression or depressive symptoms, and suicidal ideation among older adults [12,92,119-121]. Older adults with physical function impairment are experiencing difficulties in performing daily tasks or mobility, which indicates they may become more dependent and treat themselves as a burden to others. In particular, deeply influenced by Confucian culture, Chinese older adults may have high expectation of filial piety of the younger generation and rely on their children or other family members [50]. Thus, emotional support and caregiving from children or family members tend to be important for Chinese older adults, especially for those with physical function impairment. Unfortunately, the actual behaviors of children do not always fit the expectation of parents due to having difficulty of work-life balance, and disparities of culture values between East and West [50]. That could be one explanation why psychological issues are commonly reported among Chinese older adults [140-144], and why physical function impairment among Chinese older adults is linked to depressive symptoms or suicidal ideation.

Overall, there are several limitations in the current research field of physical function concerning Chinese older adults. First, there is a lack of a standardized evaluation to measure one's physical function. Older adults' physical function is usually measured by self-reported evaluation or observed performance-based tests. For physical and mobility disability assessments, Activities of Daily Living (ADL), Instrumental Activities of Daily Living Scale (IADL), the Barthel Index, and the Health Assessment Questionnaire (HAQ) Disability Scale are most commonly used. For functional assessment tools, Tinetti Performance Oriented Mobility Assessment Tool, Walking Speed, Functional Independence Measure, and Timed Up and Go (TUG) test are considered [145-147]. A variety of instruments are used in different studies in order to meet different research needs. However, this also decreases the ability to compare across studies. Even for studies that use same measurement, cutoff points that define impairment may differ, leading to vast variations in estimating the prevalence of physical function impairment. Researchers should expand efforts to develop a more-consistent instrument and standardized cutoff points for future assessment of physical function impairment to facilitate comparisons across studies. Another limitation is the discordance between self-reported and performance based tests in previous research [56]. For self-report tests, Chinese older adults may be reluctant to report true situation about their physical function status due to the traditional Chinese value of "saving face". As a result, the accuracy and credibility of results could be reduced. Additionally, the sample sizes of most existing studies among Chinese older adults are relatively small. A large and representative sample size is encouraged to provide more convincing evidence for future strategy planning and policy making in health promotion. In terms of the limitations of this review, we did not include peer-reviewed manuscripts in non-English languages. Nevertheless, this systematic review characterizes the state-of-science in physical function, reveals physical function impairment is an important issue among global Chinese aging population, as well as illustrates the future research direction and practical strategies.

Future Research Directions

Knowledge gap: While it has been shown that many medical conditions are associated with increased risk of physical function impairment among Chinese older adults [148], there are a few particular areas which have yet to be adequately explored. First, there is a lack of research that addresses the association between co-morbidity and physical function impairment among Chinese aging group, which has been shown in a Canadian community and an American community [7,8]. Additionally, visual impairments but not hearing impairments were reported to be a risk factor of future ADL disability [149], but little is known about these associations among Chinese aging population. Larger healthcare facilities may have more health and human recourses that can provide older adults satisfactory care and support, decreasing the risk of experiencing physical limitations, but there are many unknown confounding factors between healthcare unit size and older adults' physical status, and more studies are still needed to further demonstrate this association. Furthermore, research has focused on the risk factors of physical function impairment, while inadequately addressing its protective factors.

Similarly, there are several consequences of physical function impairment that has been widely reported in other race groups, but are not yet fully examined among Chinese older adults, especially in overseas Chinese aging population, such as increased risk of mortality [13,48], attempted suicide or suicidal ideation [150,151], and depression or depressive symptoms [152,153]. As one of the most severe outcomes of physical function change, more attention should be paid to the relationship between mortality and physical function impairment. Additionally, attempted suicide or suicidal ideation may further result in higher risk of mortality, suggesting the importance of offering psychological counseling service to prevent suicide or suicidal ideation for those vulnerable groups. More studies are still needed to evaluate the associations between depression and depressive symptoms or other mental disorders and older adults' physical function impairment, as well as examine how mental health care can prevent Chinese older adults with physical function impairment from developing severe psychological illnesses.

Moreover, for overseas Chinese older adults, there is limited information generated from communities or institutes in Singapore, Canada, and the United States. Since an increasing number of Chinese immigrants are living in different foreign countries, and overseas population might have different experience in physical function impairment than Chinese population in China due to diversity of socioeconomics, acculturation levels, citizenship and immigration status, culture beliefs, language, and access to healthcare services [154-156], a lack of representative studies in other regions may impede to develop a comprehensive understanding on this aging issue. More studies conducted in overseas Chinese communities, as well as more comparative data across different regions and cultural groups are needed.

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To advance our understanding of trends in physical function change in Chinese aging population over time, longitudinal studies are needed among the aging population living in the Mainland China as well as overseas Chinese communities. Despite quantitative analysis, qualitative studies can help to generate an in-depth understanding of the concerns, needs, and barriers of older adults with physical function impairment as well as the cultural context behind this aging issue. It is also important to better provide social and healthcare services for older adults and to develop effective intervention programs.

Cultural components among Chinese aging population: First, existing studies did not fully consider the potential influence caused by filial piety or caregiving and how it relates to poor physical performance in Chinese population. Considering the culture components could be critical for better research and intervention design to address potential biases when understanding physical function in a Chinese population. Second, one study conducted in Chicago reported that a decline in physical function was related to higher risk of elder abuse [20], while other studies indicated that there was no significant association between physical dependence and a greater risk of elder abuse [157,158]. Given that elder abuse is a serious and common public health concern among Chinese older adults [158], older adults may face burden of grand-parenting [159], and there is a lack of evidence-based research conducted in diversity Chinese communities, it is important to explore the complexity of the relationship between physical function impairment and elder abuse. Third, the ethnic difference of physical function impairment between Chinese older adults and other racial groups has been shown in some previous studies [29,56,125]. More studies are still needed to explore these across racial groups by considering disparities in life styles, eating habits, geographic settings, socio-economic characteristics, and cultural values. Further, there is diversity within Chinese aging population, which has yet to be explored.

Implications for Practical Strategies

There are implications for practical strategies from individual, familial, and policy levels. First, "self-improvement" is important to promote healthy aging and prevent physical function impairment among Chinese older adults [160]. Given the evidence regarding possible intervention strategies, moderate physical activities and partnerships with trained medical professionals may be helpful to maintain physical health for Chinese older adults. Our review findings also suggest that mental health were related to older adults' physical function status. Intervention strategies which emphasize physical, psychological and social wellbeing, either through clinical trials or social services, should consider linguistically and culturally appropriate measures to better serve diverse aging population. Given the diversity of physical function in older adults' socio-demographic characteristics, risk and protective factors, and health status, the intervention programs design and health policy making should especially focus on these high-risk groups. Cost effectiveness and applicability of new developed intervention programs should also be considered. Additionally, policy makers should invest in more resources for all individuals, families, and systems involved in caring for Chinese older adults based on the concerning prevalence rates of physical impairment globally. Caring for impaired older adults may be a traditional Chinese value; however, especially for overseas Chinese communities, Chinese adult children may experience a disproportionate burden due to lack of linguistically and culturally appropriate support. Future efforts should expand to promote the collaboration between research institutions and community organizations to better address these concerns and needs [161].

Furthermore, safe living environments for older adults are important for Chinese older adults with physical impairments. As people age, falls are more frequent and serious due to poor balance function, weak muscle strength, and thinning of bones [136]. The home environmental hazards should be removed to prevent incidence falls or injuries. Legislation can be an effective safeguard of rights of older adults with physical function impairment. In 1990, the U.S. Congress enacted the Americans with Disabilities Act (ADA) to prevent disabilities from discrimination, to defend their rights, and to take care of them regarding employment, public entities and transportation, public accommodations and commercial facilities, and telecommunications. China also promulgated the Law of the People's Republic of China on the Protection of Disabled Persons in 1990 to protect disabilities on aspects ranging from rehabilitation, education, employment, cultural life, welfare, environment, to legal liabilities [162]. While these legislations have promoted health equity for older adults, special attention should be paid to the accessibility of these resources for individuals who have limited English proficiency and may experience other cultural or structural barriers in accessing services. Although this multifaceted approach across individual, familial, and structural level may be difficult, joint efforts and close collaborations of the whole society are necessary to facilitate better health and quality of life among older adults, their families, as well as the general population.

Conclusion

Developing of physical function impairment is a natural process as people age. This review highlights physical function impairment; its risk and protective factors, and associated health consequences to advance the understanding of this complicated aging issue among the global Chinese population. Global longitudinal studies are critical to examine the regional and ethnic differences, effectiveness of existing intervention programs, and how physical function impairment relates to culture components such as filial piety and elder abuse. In addition, the relatively high prevalence and a growing number of physical function impairment over time in Chinese aging population reveal the importance of enhancing older adults' physical fitness and call for more physical function screenings, long-term healthcare and service services, health policy support, and multifactor intervention programs for Chinese older adults. Also, the effectiveness, feasibility, and sustainability of existing interventions should be evaluated.

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