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Status of Intrinsic Capacity Decline in China: Prevalence, Associated Factors, and Implications for Clinical Care

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3 **1 Status of Intrinsic Capacity Decline in China: Prevalence, Associated Factors, and**
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5 **2 Implications for Clinical Care**
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3 **16 Abstract**

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5 **17 Objectives:** The WHO proposed intrinsic capacity (IC) as a new model to capture an individual's
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8 **18** functions and capacities across lifetime. We aimed to investigate the prevalence of and factors
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10 **19** associated with decline in IC (DIC) and examine associations between IC and adverse outcomes
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12 **20** in China.

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14 **21 Design:** Cross-sectional study.

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16 **22 Setting:** Community, China.

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18 **23 Participants:** Data were derived from the China Comprehensive Geriatric Assessment Study. IC
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24 comprised five domains: locomotion, cognition, vitality, sensory, and psychological domains.
25 Participants were deemed DIC if they had any domain decline(s). Sociodemographic
26 characteristics, chronic diseases, geriatric syndromes, and adverse outcomes were examined.

27 Results: Of 5,823 community-dwelling participants aged 60–98 years, 2,506 were DIC (weighted
28 39.9%): 57.7% in Western, 38.3% in Northern, 33.7% in Northwest, 36.1% in Middle, 16.9% in
29 Eastern, and 19.8% in Northeast China. Participants with decline in locomotion, cognition, vitality,
30 sensory, and psychological domains numbered 1,039 (17.8%), 646 (11.1%), 735 (12.6%), 824
31 (14.2%), and 713 (12.2%), respectively. Age, northern residence, low education, poor marital
32 status, low income, less exercise, less meat intake, insomnia, memory loss, urinary incontinence,
33 constipation, slowness, chronic obstructive pulmonary disease, and osteoarthritis independently
34 influenced DIC. After adjusting for age, sex, area, district, marriage, education, waist-hip ratio,
35 smoking, alcohol consumption, exercise, income, and chronic diseases, DIC was independently
36 associated with risk of frailty, disability, fall, fracture, and immobility.

37 Conclusion: DIC prevalence in China is high. IC was significantly associated with adverse
38 outcomes, after adjusting for related variables. Efforts promoting IC to delay functional

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3 39 dependence should focus on modifiable factors, such as worse social factors, poor lifestyle, chronic
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5 40 diseases, and geriatric syndromes.
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10 42 **Keywords:** Intrinsic capacity; Older Adults; Prevalence; Frailty
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For peer review only

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3 45 **Article summary**
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5 46 **Strengths and limitations of this study**
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8 47 ● To the best of our knowledge, this study is the first large nationally representative sample of
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10 48 population-based older people focusing on intrinsic capacity in China.
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12 49 ● Most of the indicators of intrinsic capacity such as locomotion, cognition, and psychological
13
14 50 domain were assessed by unified measured performance tests.
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16
17 51 ● This study provided preliminary understanding of the intrinsic capacity situation in China,
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19 52 which suggests ways to successfully put intrinsic capacity into clinical practice to contribute
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21 53 to complex integrated care strategies for older persons with declined intrinsic capacity.
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23
24 54 ● The relatively small sample size and cross-sectional design limit generalizability of the results
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26 55 ● We used a composite total score instead of a weighted score, so further statistical approaches
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28 56 should be conducted to compute IC score.
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58 Introduction

59 The increasing global disability burden associated with rapid population aging causes physical,
60 social, and mental health problems, which challenges the health care system for older people ¹. To
61 cope with the demands of increasing numbers of frail community-dwelling older persons with
62 multiple complex needs, implementing integrated care is necessary to improve their well-being ².
63 As such, the World Health Organization (WHO) has developed the Integrated Care for Older
64 People (ICOPE) approach and proposed an innovative public health model for healthy ageing
65 focusing on concepts of intrinsic capacity (IC) and functional ability, with strong recommendations
66 for developing comprehensive approaches such as quality integrated care to maintain IC and
67 functional ability. This highlights the importance of integrated care in improving quality of life in
68 the older population ^{3,4}. A recent study showed that an integrated health and social care model
69 reduced frailty in community-dwelling older people ⁵.
70 IC comprises all the individual's physical and mental capacities ⁴. The new IC model has shifted
71 the concept of "healthy ageing" from disease-centered to function-centered paradigms, which
72 opens up opportunities for intervention at an early stage to slow down progression to disability and
73 care-dependency. WHO proposes five components to assess IC: locomotion, cognition, vitality,
74 sensory, and psychological domains ^{3,4}. Although each component is associated with adverse
75 health events in older people, few studies have focused on the combined components ^{6,7}. As it
76 reflects biological aging, monitoring IC may provide an innovative method to promote healthy
77 ageing ⁸. While evidence about factors associated with decline in IC (DIC) is limited, with
78 increased healthcare utilization, identification of vulnerable populations at risk and further
79 intervention could improve their physical capacity and functional ability ⁴.
80 While disease burden affects public health systems and increases expenses, an IC approach might

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3 81 allow a better understanding of an individual's functional trajectories and vulnerabilities to
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5 82 develop strategies for prevention or to delay progression of DIC, even during a catastrophic event
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8 83 as the coronavirus disease ⁹. The healthcare system should prioritize strategies targeting chronic
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10 84 diseases in the older population to reduce the disabilities burden ¹⁰. Although the concept of IC
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12 85 has been used in several observational studies ¹¹, no studies have been conducted in China.
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14 86 Therefore, to facilitate the evaluation of integrated primary care approaches for older patients, the
15
16 87 present study focuses on (1) the prevalence and factors associated with DIC proposed by the WHO,
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18 88 and (2) the association between IC and frailty, disability, falls, fracture, and immobility in
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20 89 community-dwelling older people in China.
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26 91 **Methods**

27 92 *Participants*

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30 93 Data were obtained from the China Comprehensive Geriatric Assessment Study (CCGAS, 2011–
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32 94 2012), a population-based face-to-face survey of adults aged 60 years or over from rural and urban
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34 95 areas of China. Further details regarding the CCGAS have been reported. Briefly, seven cities
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36 96 (Beijing, Xi'an, Harbin, Chengdu, Chongqing, Changsha, and Shanghai) from seven different
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38 97 provinces were chosen based on well-established cluster, stratification, and random selection
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40 98 statistical sampling techniques; these cities represent six main regions in China (northern, middle,
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42 99 eastern, northwestern, southwestern, and northeastern). A total of 6,867 older adults were included,
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46 100 and 1,040 participants were excluded because of missing data, resulting in 5,823 with complete IC
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48 101 data included in this analysis. All study participants provided informed consent, and the study
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50 102 design was approved by the ethics review board of Xuanwu Hospital Capital Medical University.
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54 103 *Demographics, lifestyles, and diseases*

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3 104 A door-to-door survey was conducted by formally trained interviewers using the standard
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5 105 Comprehensive Geriatric Assessment (CGA) instrument. Data gathered included
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7 106 sociodemographic characteristics, anthropometric measurements, health status, personal habits,
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9 107 and mental health. Medical conditions such as self-reported history of chronic disease diagnosed
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11 108 by a doctor and geriatric syndromes were recorded.

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15 109 *IC construct*

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17 110 IC was assessed by the following five domains recommended by WHO ^{3,12} and available in our
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19 111 cohort.

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21 112 Locomotion was assessed by a short physical performance battery ¹³. The balance test comprises
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23 113 three parts: standing unsupported for 10 seconds with the feet together; a semi-tandem stand; and
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25 114 a full-tandem stand. Subjects who were unable to complete each test received a score of 1;
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27 115 otherwise, they were scored 0. The chair-stand test was performed with the subject seated in a
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29 116 chair, with the feet flat on the floor and arms held flat against their side with the elbows at 90°.
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31 117 Subjects who were able to stand five times from the chair received a score of 1, those who partly
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33 118 completed this task scored 0.5, and those who could not do so scored 0. A 20-meter walking test
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35 119 was also conducted; those who were able to walk 20 meters scored 1, those who walked less than
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37 120 20 meters scored 0.5, and those could not walk scored 0.

38
39 121 Cognition was assessed by the Mini-Mental State Examination, with a total score range of 0–30
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41 122 ¹⁴. The thresholds for participants who were illiterate or who were educated up to elementary
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43 123 school, middle school, and high school or above were 17, 20, and 24, respectively. Participants
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45 124 who scored below the threshold value for their education group were regarded as mildly
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47 125 cognitively impaired (score of 1), and those below 15 were regarded as moderately to severely
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49 126 cognitively impaired (score of 0).

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3 127 Vitality was assessed by body mass index (BMI), which was calculated by dividing the weight in
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5 128 kilograms by height in meters squared. BMI cutoffs were based on Asian adjustments. BMI above
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7 129 20kg/m^2 received a score of 2, $18.5\text{--}20\text{ kg/m}^2$ was scored 1, and $\leq 18.5\text{ kg/m}^2$ was scored 0.

10 130 Sensory domain was assessed by self-reported visual and hearing impairment. Vision capacity was
11
12 131 considered intact when the older person did not report “eyesight problems” that interfered with
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14 132 their activities, and they were not identified by the interviewer as being functionally blind. Hearing
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16 133 capacity was considered intact when the older person did not report “hearing problems or deafness”
17
18 134 that interfered with their activities, and they were not identified by the interviewer as being
19
20 135 profoundly deaf. Participants with both vision and hearing impairments received a score of 0, those
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22 136 with either vision or hearing impairment received a score of 1, and those with both vision and
23
24 137 hearing capacities intact scored 2.

28 138 Psychological domain was measured by the 30-item Geriatric Depression Scale¹⁵. Scores from 0
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30 139 to 10 represent an intact psychological domain (score of 2); scores from 11 to 20 represent mild
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32 140 depression (score of 1); scores from 21 to 60 represent moderate to severe depression (score of 0).
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34 141 For each of the above five items, participants were scored either 0 (representing severe decline), 1
35
36 142 (representing mild decline), or 2 (representing intact IC). The IC total score ranged from 0–10;
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38 143 higher scores indicated better performance.

144 *Adverse outcomes*

145 Physical function was assessed as activities of daily living (ADL) and instrumental activities of
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147 146 daily living (IADL). The list of activities consisted of 14 items (eating, grooming, dressing,
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149 147 transferring in and out of bed, bathing, walking inside the house, using the toilet, cooking,
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151 148 managing finances, driving or using public transportation, shopping, walking 250 meters, cutting
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153 149 toenails, and climbing stairs), and an individual’s performance on each item was classified as

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3 150 independent, partially dependent, or completely dependent. Those with one or more impaired ADL
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5 151 or IADL functions were defined as disabled. The frailty index derived from CGA was measured
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7 152 based on six variables: demographic characteristics, physical health, physical function, living
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9 153 behavior and social function, mental health, and cognitive function ¹⁶. Frailty was defined as a
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11 154 score ≥ 0.25 . We defined fractures as spontaneous fractures over the previous two years. Falls were
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13 155 defined as those that occurred twice in the past year. Immobility was self-reported.
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156 *Statistical methods*

157 EpiData was used to establish the database, and input and automatically verify the data. All
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21 158 statistical analyses were performed using SPSS (Chicago, IL, USA, version 11.0). Count data were
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23 159 expressed as percentages. Chi-square tests, t-tests, and one-way analysis of variance were
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25 160 performed. The standard rates calculated using the national standard population composition ratio
26
27 161 as at the Sixth National Census (2010). A forward stepwise logistic regression was conducted to
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29 162 explore the association between the factors and DIC or between DIC and adverse outcomes. A P-
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31 163 value of < 0.05 was considered statistically significant.
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165 **Results**

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40 166 Of the total 5,823 older adults, the average IC score was 9.14 ± 1.304 , and 2,506 were DIC, yielding
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42 167 a prevalence of 43.0% (weighted 39.9%). A total of 3,317 (57.0%), 1,512 (26.0%), 636 (10.9%),
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44 168 271 (4.7%), 75(1.3%), and 12 (0.2%) participants showed decline in 0, 1, 2, 3, 4, and 5 domains,
45
46 169 respectively. The prevalence of DIC was higher in women than in men (43.0% vs. 36.7%). The
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48 170 prevalence of DIC among older adults in rural areas was higher, by 1.36 times, than that in urban
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50 171 areas. The prevalence of DIC increased with age, with the highest observed in individuals aged
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52 172 ≥ 80 y (66.6%) and the lowest among those aged 60–64 y (28.6%) (Table 1). The number of
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3 173 participants with decline in locomotion, cognition, vitality, sensory, and psychological domains
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5 174 was 1,039 (17.8%), 646 (11.1%), 735 (12.6%), 824 (14.2%), and 713 (12.2%), respectively. For
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7
8 175 each domain, the prevalence was higher in females and those with rural residence, and increased
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10 176 with age, although there was no association between psychological domain and age (Table S1).
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12 177 We observed differences in the prevalence of DIC among the six regions: 57.7% in Western China,
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14 178 38.3% in Northern China, 33.7% in Northwest China, 36.1% in Middle China, 16.9% in Eastern
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16 179 China, and 19.8% in Northeast China (Figure 1A). The prevalence of DIC was higher in northern
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18 180 than southern regions (46.9% vs 36.7%; Figure 1B). The IC score decreased with increasing age
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20 181 (9.53 ± 0.88 , 49.37 ± 1.06 , 9.18 ± 1.22 , 8.96 ± 1.39 , 8.35 ± 1.73 ; Figure 1D) and was higher in men than
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22 182 women (9.24 ± 1.19 vs 9.06 ± 1.38 ; Figure 1C).
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25 183 Next, we observed the prevalence of DIC in different regions according to geography, sex, and
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27 184 age. In urban areas, the weighted prevalence of DIC differed across the six regions, with western
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29 185 urban regions showing the highest rates and eastern urban regions showing the lowest rates: 43.1%
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31 186 in Western, 36.1% in Middle, 33.7% in Northwest, 30.7% in Northern, and 19.8% in Northeast,
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33 187 and 11.8% in Eastern China. Older adults living in rural areas included those residing in Beijing
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35 188 and Chengdu, and the prevalence of DIC was higher in Chengdu than Beijing (74.1% vs 47.2%).
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37 189 The prevalence of DIC among the six regions was different when analyzed according to sex and
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39 190 age, with western regions showing the highest rate in both men and women, and in those aged <75
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41 191 y, and those aged ≥ 75 y, the eastern regions showing the lowest rates in both men and women, and
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43 192 those aged <75 y, and east-north region showing the lowest rates in those aged ≥ 75 y (Figure 2).
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45 193 When we compared social-psychological factors, chronic diseases, and geriatric syndromes, a high
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47 194 prevalence of DIC was observed in illiterate participants, those with low income, not married, who
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49 195 did not exercise, with less meat intake and alcohol consumption. Those who had chronic diseases
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3 196 such as coronary heart disease, stroke, kidney disease, chronic obstructive pulmonary disease, and
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5 197 osteoarthritis, as well as geriatric syndromes had a higher prevalence of DIC, while there was a
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7 198 lower prevalence of DIC in older adults without diabetes (Table S2). The prevalence of DIC among
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10 199 individuals with ≥ 5 (62.5%) chronic diseases was about two times higher than that among
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12 200 individuals without chronic disease (30.9%).

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14 201 With DIC as the dependent variable and the above factors as independent variables, forward
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16 202 logistic analysis showed that older age, northern region, low education, poor marital status, low
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18 203 income, less exercise, less meat intake, insomnia, memory decline, urinary incontinence,
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20 204 constipation, slowness, chronic obstructive pulmonary disease, and osteoarthritis, were
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22 205 independent factors influencing DIC in older adults (Table 2).

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24 206 We further compared the frequency of adverse clinical outcomes between non-DIC and DIC
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26 207 groups. Participants with DIC were much more likely to be frail (22.2% vs 1.2%), disabled (15.0%
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28 208 vs 1.0%), and have falls (7.9% vs 1.8%), fractures (4.7% vs 2.2%), and immobility (20.4% vs
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30 209 3.4%). Logistic regression showed that, after adjustment for age, sex, area, district, marriage,
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32 210 education, waist-hip ratio, smoking, alcohol consumption, exercise, income, and chronic diseases,
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34 211 DIC was independently associated with risks of frailty (adjusted OR = 19.021), disability (adjusted
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36 212 OR = 8.611), falls (adjusted OR = 3.053), fractures (adjusted OR = 1.656), and immobility
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38 213 (adjusted OR = 4.403) (Table 3).

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45 215 **Discussion**

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47 216 In a nationally representative cross-sectional study, the weighted prevalence of DIC was as high
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49 217 as 39.9% in community-living Chinese adults aged ≥ 60 years, which was about five times higher
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51 218 than the prevalence of frailty in the same population¹⁷. The frequency of participants with decline
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3 219 in locomotion, cognition, vitality, sensory, and psychological domains was 17.8%, 11.1%, 12.6%,
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5 220 14.2%, and 12.2%, respectively. The traditional care model for older adults is mostly disease-
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7 221 centered; however, frailty, as an increasingly problematic consequence of population aging,
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10 222 threatens the sustainability of healthcare resources where most people seek healthcare attention
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12 223 only when experiencing symptoms. Furthermore, some studies reported that current integrated
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14 224 care models did not significantly reduce utilization nor consistently reduce mortality¹⁸. Thus, an
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16 225 IC model may support modernization of current healthcare systems and meet the requirements of
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18 226 each older adult. The ongoing INSPIRE study conducted in Europe will test the implementation
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20 227 and follow up of the ICOPE tool¹⁹.
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23 228 This study showed the prevalence of DIC participants was higher in northern than southern regions.
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25 229 Furthermore, there were differences in the prevalence of DIC among the six regions, which was
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27 230 consistent with previous studies in which the incidence of frailty²⁰ and prevalence of disability²¹
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29 231 was more common in the north than the south, indicating the importance of implementing the
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31 232 ICOPE protocol, especially in northern China. We found that IC score decreased with increasing
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33 233 age, while longitudinal studies showed that the effect of age on incidence of ADL dependency was
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35 234 modified by IC²².
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38 235 Logistic regression showed that age, region, low education, poor marital status, low income, less
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40 236 exercise, less meat intake, insomnia, memory loss, urinary incontinence, constipation, slowness,
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42 237 chronic obstructive pulmonary disease, and osteoarthritis were independent factors influencing
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44 238 DIC in older adults, which shows that efforts to develop strategies and health policies to
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46 239 identify and manage modifiable variables are urgently needed. A longitudinal study in New
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48 240 Zealand showed that neighborhood environments and IC interact to affect quality of life in older
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50 241 persons²³. Since the above associated factors independently affected the persons' IC, multidomain
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3 242 and complex interventions provide a better option for prevention and management of DIC.
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5 243 Accordingly, WHO recommends screening using instruments such as the ICOPE screening tool
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7 244 as the first step at the primary care level ^{3,4,24}.

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10 245 We showed that after adjusting for sociodemographic variables, age-related factors, and chronic
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12 246 conditions, DIC was independently associated with risk of frailty, disability, falls, fractures, and
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14 247 immobility, which is in line with the finding that IC predicted the incidence of loss of ADLs and
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16 248 IADLs ²², and further indicates the need for worldwide implementation of prevention of DIC. The
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18 249 World Report on Ageing and Health proposes the concept of IC as central for healthy ageing ⁴.
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20 250 The term frailty refers to health deficits while IC emphasizes positive aspects and perhaps includes
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22 251 the biological state that underpins the frailty phenotype. Thus, IC may be considered as an
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24 252 evolution of frailty by creating a bridge between geroscience and healthy aging ¹¹. Furthermore,
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26 253 an IC approach has the benefit of tracing trajectories for progression to adverse clinical outcomes
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28 254 such as frailty and disability, as well as the effectiveness of interventions implemented at the
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30 255 individual level. Thus, an IC model is of great importance in the face of unmet needs.

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32
33 256 This study has several limitations. First, the relatively small sample size and cross-sectional design
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35 257 limit generalizability of the results. Further longitudinal studies with a larger sample size are
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37 258 urgently needed. Second, vitality was defined by BMI instead of specific nutritional assessment,
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39 259 which may have affected some of the results, since most of the diabetic patients had a higher BMI,
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41 260 which could explain the lower DIC in participants with diabetes in the study. Third, we used a
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43 261 composite total score instead of a weighted score, so further statistical approaches should be
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45 262 conducted to compute IC score.

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47 263 To the best of our knowledge, this study is the first large nationally representative sample of
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49 264 population-based older people focusing on IC in China. Second, most of the indicators of IC such
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3 265 as locomotion, cognition, and psychological domain were assessed by unified measured
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5 266 performance tests; thus, response or interviewer bias was avoided. Third, standardized protocols
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8 267 as well as regularly and randomly performed internal quality checks of the data were used to avoid
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10 268 the quality disadvantage of the multi-center design.

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12 269 The current study provided preliminary understanding of the IC situation in China, which suggests
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14 270 ways to successfully put IC into clinical practice to contribute to complex integrated care strategies
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17 271 for older persons with DIC. This study has the potential to enhance our understanding of the
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19 272 importance and promising future of an IC model of disease and treatment effects in this vulnerable
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21 273 population. Consistent with the WHO recommendations, this study indicates screening and
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23 274 interventions should be provided, especially for vulnerable participants. As such, China has
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25 275 already put the theory-based ICOPE approach into clinical practice and launched a pilot multi-
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27 276 center study called “China Aging, Resilience and Intrinsic Capacity Study (CARICS)” to identify
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30 277 and manage DIC to improve well-being among community-living older adults.

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3 **386 Captions for Tables and Figures**
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5 387 Table 1. Prevalence of declines in intrinsic capacity in older adults by sex, area, and age

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7 388 Table 2. Stepwise forward logistic regression for associated factors with decline in intrinsic
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10 389 capacity

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12 390 Table 3. Multivariate logistic regression analysis (forward method) for DIC associated with risk
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15 391 of adverse clinical outcomes

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17 392 Figure 1. The intrinsic capacity in different region, age, and sex groups. (A) The comparison of
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19 393 the weighted prevalence of DIC among the six regions of China (Chi-square test, $p < 0.01$). (B)
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21 394 The comparison of the weighted prevalence of DIC between North China and South China (Chi-
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23 395 square test, $p < 0.01$). (C) The comparison of the intrinsic capacity score among different age
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25 396 groups (One-way ANOVA, $p < 0.01$). (D) The comparison of the intrinsic capacity score between
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27 397 males and females (t-test, $p < 0.01$). Abbreviations: ANOVA, analysis of variance; DIC, decline
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29 398 in intrinsic capacity; IC, intrinsic capacity.
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33 399 Figure 2. The weighted prevalence of declines in intrinsic capacity in community-dwelling older
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35 400 adults living in the urban area (A1), rural area (A2), male (B1), female (B2), <75 ys (C1) and ≥ 75
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37 401 ys (C2). All were analyzed using the Chi-square test, $p < 0.01$.
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40 402 Table S1. Prevalence of each declined domain in older adults by sex, area, and age

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42 403 Table S2. The effect of social factors, lifestyle and chronic conditions on DIC
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Table 1. Prevalence of declines in intrinsic capacity in older adults by sex, area, and age

	Total n	DIC n (%)	Weighted (%)	Number of Declined Domains					
				0	1	2	3	4	5
All sample	5823	2506(43.0)	39.9	3317(57.0)	1512(26.0)	636(10.9)	271(4.7)	75(1.3)	12(0.2)
Sex*									
Male	2518	1030(40.9)	36.7	1488(59.1)	652(25.9)	266(10.6)	81(3.2)	27(1.1)	4(0.2)
Female	3305	1476(44.7)	43.0	1829(55.3)	860(26.0)	370(11.3)	190(5.7)	48(1.5)	8(0.2)
Area*									
Urban	3494	1243(35.6)	32.7	2251(64.4)	868(24.8)	275(7.9)	81(2.3)	18(0.5)	1(0)
Rural	2329	1263(54.2)	50.1	1066(45.8)	644(27.7)	361(15.5)	190(8.2)	57(2.4)	11(0.5)
Age (ys)*									
60-64	1471	428(29.1)	28.6	1043(70.9)	309(21.0)	85(5.8)	30(2.0)	4(0.3)	0(0)
65-69	1179	414(35.1)	34.9	765(64.9)	271(23.0)	100(8.5)	34(2.9)	9(0.8)	0(0)
70-74	1165	515(44.2)	43.6	650(55.8)	337(28.9)	116(10.0)	46(3.9)	16(1.4)	0(0)
75-79	1119	562(50.2)	50.3	557(49.8)	325(29.0)	150(13.4)	62(5.5)	20(1.8)	5(0.4)
≥80	889	587(66.0)	66.6	302(34.0)	270(30.4)	185(20.8)	99(11.1)	26(2.9)	7(0.8)

Note: *P<0.05; DIC, decline in intrinsic capacity

Table 2. Stepwise forward logistic regression for associated factors with decline in intrinsic capacity

Factors	B	S.E.	Wald	df	Sig	OR	95% CI
Older age	0.647	0.093	48.426	1	<0.001	1.910	1.592-2.291
North region	0.466	0.090	26.993	1	<0.001	1.594	1.337-1.901
Low education	0.890	0.143	38.657	1	<0.001	2.435	1.839-3.223
Poor marital status	0.395	0.105	14.157	1	<0.001	1.485	1.209-1.825
Low income	0.388	0.094	16.974	1	<0.001	1.474	1.226-1.773
Less exercise	0.293	0.099	8.690	1	0.003	1.340	1.103-1.628
Less meat intake	0.260	0.089	8.532	1	0.003	1.296	1.089-1.543
Insomnia	0.453	0.095	22.735	1	<0.001	1.572	1.305-1.894
Urinary incontinence	0.680	0.209	10.605	1	0.001	1.974	1.311-2.973
Constipation	0.408	0.126	10.605	1	0.001	1.504	1.175-1.924
Memory decline	0.714	0.083	73.427	1	<0.001	2.043	1.735-2.405
Slowness	0.407	0.102	15.908	1	<0.001	1.502	1.230-1.835
COPD	0.853	0.215	15.758	1	<0.001	2.347	1.540-3.576
Osteoarthritis	0.534	0.095	31.785	1	<0.001	1.706	1.417-2.054
Constant	-2.028	0.104	379.542	1	<0.001	0.132	

Note: COPD, chronic obstructive pulmonary disease.

The variables not in the equation were sex, living areas, alcohol consumption, coronary heart disease, diabetes, stroke and kidney disease.

Table 3. Multivariate logistic regression analysis (forward method) for DIC associated with risk of adverse clinical outcomes

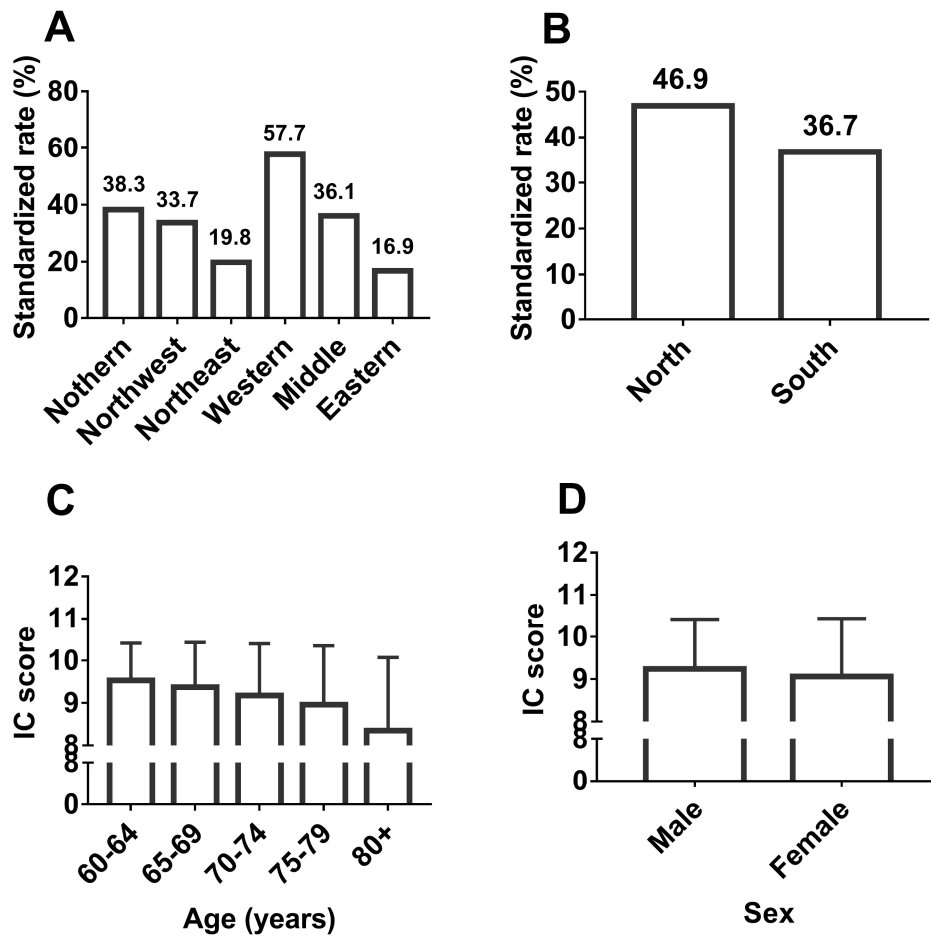
	Model 1			Model 2		
	OR	95% CI	P value	OR	95% CI	P value
Frailty	19.625	14.044-27.423	<0.001	19.021	12.882-28.084	<0.001
Disability	12.628	8.750-18.225	<0.001	8.661	5.925-12.660	<0.001
Fall	3.671	2.699-4.993	<0.001	3.053	2.232-4.177	<0.001
Fracture	1.965	1.448-2.666	<0.001	1.656	1.195-2.295	0.003
Immobility	6.098	4.903-7.584	<0.001	4.403	3.500-5.538	<0.001

Reference: Non-DIC.

Model 1: Adjusted by age, sex, area and district.

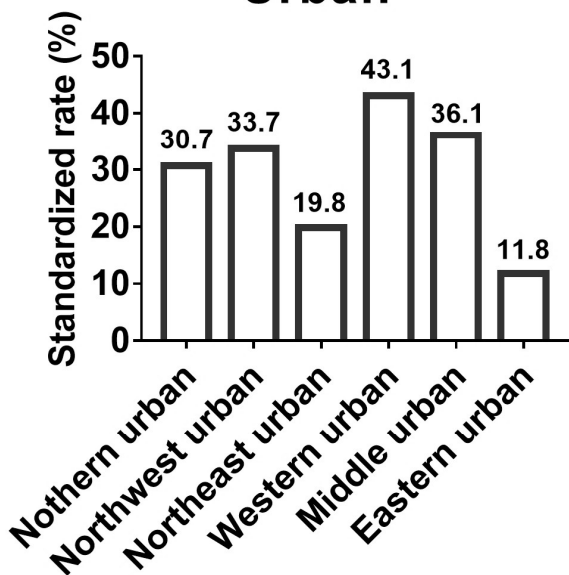
Model 2: Fully adjusted Cox proportional hazard analysis. Adjusted by age, sex, area, district, marriage, education, waist hip ratio, smoking, alcohol consuming, exercise, income, and chronic diseases.

Note: DIC, decline in intrinsic capacity.



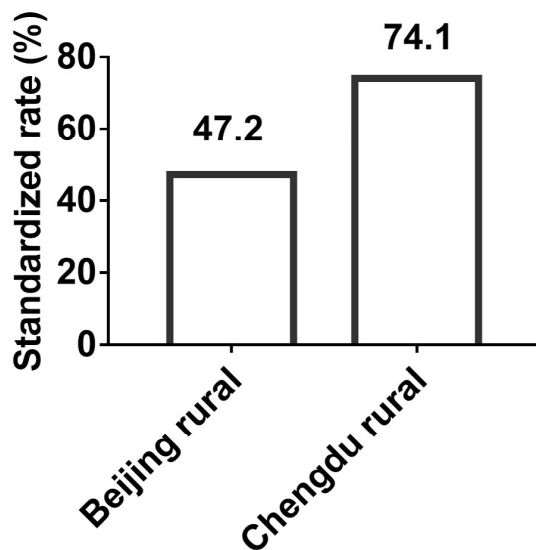
A1

Urban



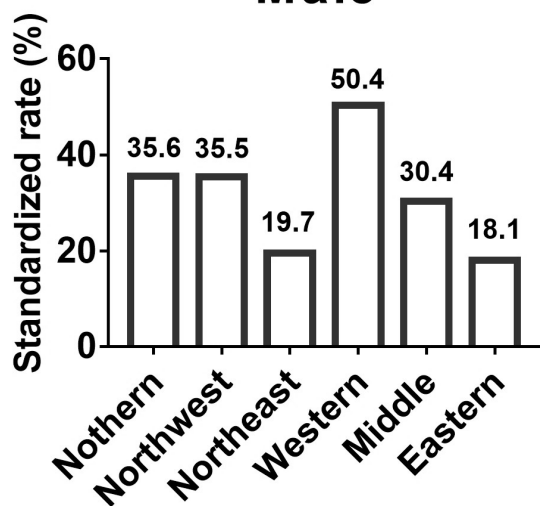
A2

Rural



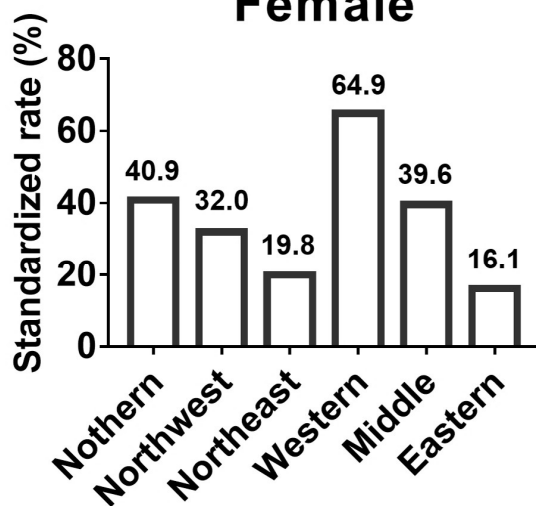
B1

Male



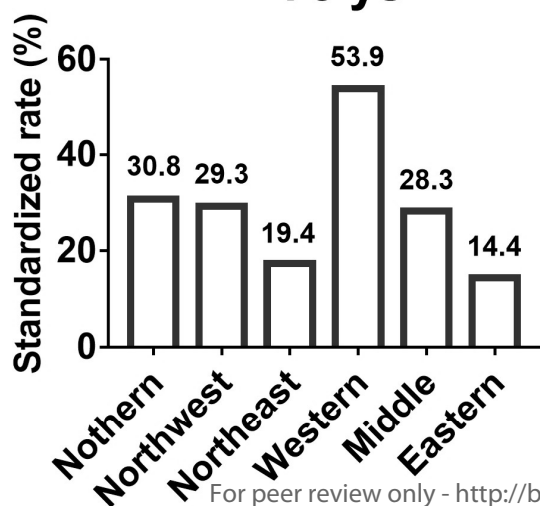
B2

Female



C1

<75 ys



C2

>=75 ys

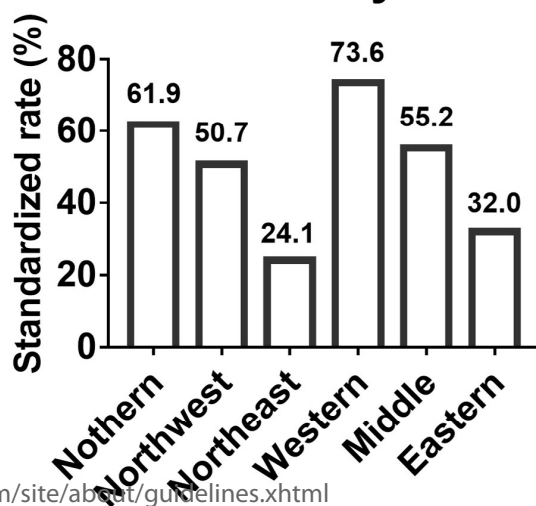


Table S1. Prevalence of each declined domain in older adults by sex, area, and age

	Total	Locomotion	Cognition	Vitality	Sensory	Psychological
All sample	5823	1039(17.8)	646(11.1)	735(12.6)	824(14.2)	713(12.2)
Sex						
Male	2518	372(14.8)*	227(9.0)*	338(13.4)	371(14.7)	247(9.8)*
Female	3305	667(20.2)	419(12.7)	397(12.0)	453(55.0)	466(14.1)
Area						
Urban	3494	481(14.1)*	168(4.8)*	344(9.8)*	417(11.9)*	318(9.1)*
Rural	2329	548(23.5)	478(20.5)	391(16.8)	407(17.5)	395(17.0)
Age (ys)						
60-64	1471	106(7.2)*	72(4.9)*	116(7.9)*	114(7.7)*	177(12.0)
65-69	1179	129(10.9)	90(7.6)	123(10.4)	131(11.1)	136(11.5)
70-74	1165	197(16.9)	123(10.6)	141(12.1)	166(14.2)	144(12.4)
75-79	1119	256(22.9)	158(14.1)	154(13.8)	210(18.8)	138(12.3)
≥80	889	351(39.5)	203(22.8)	201(22.6)	203(22.8)	118(13.3)

Note: Data were expressed as n (%); *P<0.05

Table S2. The effect of social factors, lifestyle and chronic conditions on DIC

	Total	DIC, n (%)	Weighted (%)	χ^2	<i>P</i>
Social factors					
Education	5823				
Illiterate	1047	724(69.1)	67.7	355.086	<0.001
Not illiterate	4776	1782(37.3)	34.9		
Monthly income	5665				
<2000 Yuan	2658	1408(53.0)	49.6	227.561	<0.001
≥2000 Yuan	3007	996(33.1)	30.0		
Marital status	5818				
Married	4493	1738(38.7)	35.8	151.541	<0.001
Windowed	1325	765(57.7)	56.8		
Lifestyle					
Exercise	5808				
Yes	4594	1779(38.7)	36.1	168.600	<0.001
No	1214	722(59.5)	55.0		
Meat intake	5823				
Usually	3369	1322(39.2)	35.9	46.925	<0.001
Less	2454	1184(48.2)	45.8		
Alcohol consumption	5823				
Yes	4503	600(45.5)	40.7	4.081	0.043
No	5823	1906(42.3)	39.6		
Smoking	1320				
Yes	1658	722(43.5)	38.7	0.241	0.623
No	4165	1784(42.8)	40.5		
Chronic disease					
Hypertension	5823				
Yes	2688	1127(41.9)	39.0	2.505	0.113
No	3135	1379(44.0)	40.7		
CHD	5823				
Yes	1168	559(47.9)	46.0	13.823	<0.001
No	4655	1947(41.8)	38.5		
Diabetes	5823				
Yes	862	344(39.9)	36.6	4.041	0.044
No	4961	2162(43.6)	40.5		
Stroke	5823				
Yes	579	327(56.5)	53.3	47.323	<0.001
No	5244	2179(41.6)	38.5		
Kidney disease	5823				
Yes	259	136(52.5)	50.6	9.907	0.002
No	5564	2370(42.6)	39.4		
COPD	5823				
Yes	205	140(68.3)	66.7	55.288	<0.001
No	5618	2366(42.1)	39.0		
Liver disease	5823				
Yes	253	107(42.3)	40.0	0.062	0.803

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3	No	5570	2399(43.1)	38.7		
4	Osteoarthritis	5823				
5	Yes	1597	855(53.5)	51.2	98.993	<0.001
6	No	4226	1651(39.1)	35.9		
7						
8	Cancer	5823				
9	Yes	148	63(42.6)	39.7	0.013	0.909
10	No	5675	2443(43.0)	39.9		
11	Geriatric syndrome					
12	Insomnia	5823				
13	Yes	1427	830(58.2)	56.5	176.113	<0.001
14	No	4396	1676(38.1)	34.9		
15						
16	Memory decline	5823				
17	Yes	2629	1450(55.2)	52.6	286.447	<0.001
18	No	3194	1056(33.1)	30.2		
19	Urinary incontinence	5823				
20	Yes	257	198(77.0)	76.3	126.654	<0.001
21	No	5566	2308(41.5)	38.5		
22						
23	Constipation	5823				
24	Yes	738	430(59.1)	56.6	87.043	<0.001
25	No	5095	2076(40.8)	37.8		
26	Slowness	3306				
27	Yes	688	367(53.3)	50.2	54.008	<0.001
28	No	2618	991(37.9)	35.1		
29						

Abbreviations: DIC, decline in intrinsic capacity; ADL, activities of daily living; IADL, instrumental activities of daily living; CHD, coronary heart disease; COPD, chronic obstructive pulmonary disease.

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3 1 **Cross-sectional Study Examining the Status of Intrinsic Capacity Decline in Community-**
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5 2 **dwelling Older Adults in China: Prevalence, Associated Factors, and Implications for**
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7 3 **Clinical Care**
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3 **17 Abstract**
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6 **18 Objectives:** Intrinsic capacity (IC) was proposed by the World Health Organization as a new
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9 **19** concept for capturing an individual's functional capacities across their lifetime. We aimed to
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11 **20** investigate the prevalence and factors associated with IC decline and examine associations
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13 **21** between IC and adverse outcomes among community-dwelling older adults in China.
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16 **22 Design:** Cross-sectional study.
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19 **23 Setting:** Community, China.
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22 **24 Participants:** Data were derived from the China Comprehensive Geriatric Assessment Study, a
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25 population-based nationally representative sample. IC comprises of five domains: locomotion,
26 cognition, vitality, sensory, and psychology. Participants were deemed to have IC decline if they
27 showed a decline in any of the five domains. Sociodemographic characteristics, chronic diseases,
28 geriatric syndromes, and adverse outcomes were also examined.

29 Results: Of the 5,823 community-dwelling participants aged 60–98 years, 2,506 had IC decline
30 (weighted 39.9%): 57.7% in Western, 38.3% in Northern, 33.7% in Northwest, 36.1% in Middle,
31 16.9% in Eastern, and 19.8% in Northeast China. The number of participants with decline in the
32 locomotion, cognition, vitality, sensory, and psychological domains were 1,039 (17.8%), 646
33 (11.1%), 735 (12.6%), 824 (14.2%), and 713 (12.2%), respectively. Age, northern residence, low
34 education, being unmarried, low income, less exercise, less meat intake, insomnia, memory loss,
35 urinary incontinence, constipation, slowness, chronic obstructive pulmonary disease, and
36 osteoarthritis were related to IC decline. After adjusting for age, sex, area, district, marriage,
37 education, waist-hip ratio, smoking, alcohol consumption, exercise, income, and chronic diseases,

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3 38 IC decline was independently associated with risk of frailty, disability, falls, fractures, and
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5 39 immobility.
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9 40 **Conclusion:** The prevalence of IC decline in China is high. IC decline was significantly associated
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11 41 with adverse outcomes, after adjustment for related variables. Efforts promoting IC to delay
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13 42 functional dependence should focus on modifiable factors, including negative social factors, poor
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15 43 lifestyle, chronic diseases, and geriatric syndromes.
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22 45 **Keywords:** Intrinsic capacity; Older Adults; Prevalence; Frailty; Disability; Aging
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3 47 **Article summary**
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6 48 **Strengths and limitations of this study**
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- 9 49 ● This study is the first nationally representative large sample of population-based older people
10 focusing on intrinsic capacity (IC) in China.
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14 51 ● Most of the domains of IC were assessed using unified measured performance tests.
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17 52 ● This study provided a preliminary understanding of the IC status in China, which suggests
18 ways to successfully put IC into clinical practice contributing to the development of integrated
19 53 care strategies for older persons with IC decline.
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21 54
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23 55 ● The cross-sectional design of this study limits causality.
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26 56 ● We used a composite total score instead of a weighted score, so further statistical approaches
27 should be conducted to compute the IC score.
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59 Introduction

60 The increasing global burden of disability associated with the rapid aging of the population has
61 challenged the health care system ¹. To cope with the demands of increasing numbers of frail
62 community-dwelling older persons with multiple complex needs, the implementation of integrated
63 care healthcare model is necessary ². The World Health Organization (WHO) has proposed an
64 innovative approach known as the Integrated Care for Older People (ICOPE). This approach
65 centers around the concept of raising intrinsic capacity (IC) and functional ability to achieve
66 healthy aging. Recommendations for the development of comprehensive approaches for the
67 maintenance of IC and functional ability, including quality integrated care, have also been made.
68 Moreover, the importance of integrated care in improving quality of life in the older population
69 has been recently highlighted ^{3,4}, including reducing frailty in community-dwelling older people ⁵.

70 According to the WHO ICOPE guidelines, IC comprises an individual's physical and mental
71 capacities at any given time ⁴. This novel concept of IC has shifted the notion of "healthy aging"
72 from a disease-centered to a function-centered paradigm, creating opportunities for earlier
73 intervention to delay disability and care-dependency. The WHO proposes five components for the
74 assessment of IC, namely locomotion, cognition, vitality, sensory, and psychology ^{3,4}. Since each
75 component is associated with adverse health events in older people recent studies have focused on
76 these components in combination ⁶⁻¹⁶. As so, our in-depth understanding of the trajectory of IC
77 decline may enable us to design innovative methods for the promotion of healthy aging ¹⁷, even
78 during a catastrophic event such as the coronavirus disease ¹⁸. Although the concept of IC has been
79 used in several studies worldwide ^{12,15,16}, no studies have been conducted in China. Therefore, to
80 facilitate the evaluation of integrated care approaches for older patients, this study focuses on (1)

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3 81 the prevalence of IC and the factors associated with IC decline and (2) the associations between
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5 82 IC and geriatric conditions such as frailty, disability, falls, fractures, and immobility in a
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8 83 population-based nationally representative sample of community-dwelling older people in China.
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14 85 **Methods**

17 86 *Participants*

20 87 Data were obtained from the China Comprehensive Geriatric Assessment Study (CCGAS, 2011–
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22 88 2012), a population-based face-to-face survey of adults aged 60 years or over from rural and urban
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25 89 areas of China. Further details regarding the CCGAS have been reported ^{19–21}. For the CCGAS,
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27 90 seven cities (Beijing, Xi'an, Harbin, Chengdu, Chongqing, Changsha, and Shanghai) from seven
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30 91 different provinces were chosen based on well-established cluster, stratification, and random
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32 92 selection statistical sampling techniques. These cities represent China's six main regions (northern,
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34 93 middle, eastern, northwestern, southwestern, and northeastern). A total of 6,867 older adults were
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36 94 included in the CCGAS. A total of 5,823 participants with complete IC data were included in our
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39 95 current study and 1,040 were excluded because of missing data. A comparison of included and
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41 96 excluded participants' characteristics is shown in supplementary table S1. All participants
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43 97 provided informed consent and the study design was approved by the ethics review board of
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46 98 Xuanwu Hospital Capital Medical University.

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52 100 *Demographics, lifestyles, and diseases*

55 101 Data included sociodemographic characteristics, anthropometric measurements, health status,

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3 102 personal habits, and mental health. Medical conditions including a self-reported history of chronic
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5 103 disease diagnosed by a doctor and geriatric syndromes were recorded. Low income was defined
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8 104 as monthly income < 2,000 Yuan, no exercise was defined as exercising for < 3 hours per week,
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10 105 and meat intake was measured by asking participants if they had meat diet ≥ 2 times per week.
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16 107 *IC construct*

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19 108 IC was assessed using the five components recommended by the WHO ^{3,22} as described below:
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22 109 1)Locomotion: It was assessed by a short physical performance battery (SPPB) which comprised
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25 110 of various tests ²³. The balance test comprised three parts: standing unsupported for 10 seconds
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27 111 with feet together; a semi-tandem stand; and a full-tandem stand. Participants who were unable to
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29 112 complete each part received a score of 1; otherwise, they were scored 0. The chair-stand test was
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31 113 performed with the participant seated in a chair, with feet flat on the floor and arms held flat against
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33 114 their sides with elbows at 90°. Participants who were able to stand up five times from the chair
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35 115 received a score of 1, those who partially completed this task scored 0.5, and those who could not
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38 116 stand up at all scored 0. A 20-meter walking test was also conducted: those who were able to walk
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40 117 20 meters scored 1, those who walked less than 20 meters scored 0.5, and those could not walk at
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43 118 all scored 0. The total score range for the SPPB was 0–5.

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46 119 2) Cognition: It was assessed by the Mini-Mental State Examination (MMSE), with a total score
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49 120 range of 0–30 ²⁴. The thresholds for participants who were illiterate or who were educated up to
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51 121 elementary school, middle school, and high school or above were 17, 20, and 24, respectively.
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53 122 Participants who scored below the threshold value for their education group were regarded as
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3 123 mildly cognitively impaired (score of 1), and those who scored below 15 were regarded as
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5 124 moderately to severely cognitively impaired (score of 0).
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9 125 3) Vitality: It was assessed by body mass index (BMI), which was calculated by dividing weight
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11 126 in kilograms by height in meters squared. BMI cutoffs were based on the Malnutrition Universal
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13 127 Screening Tool (MUST)²⁵. A BMI above 20kg/m² received a score of 2, 18.5–20 kg/m² was scored
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15 128 1, and ≤ 18.5 kg/m² was scored 0.
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19 129 4) Sensory: It was assessed by a self-reported visual and hearing impairment. Vision capacity was
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21 130 considered intact when the participant did not report “eyesight problems” that interfered with their
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23 131 activities and were not identified by the interviewer as being functionally blind. Hearing capacity
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25 132 was considered intact when the participant did not report “hearing problems or deafness” that
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27 133 interfered with their activities, and was not identified by the interviewer as being profoundly deaf.
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29 134 Participants with both visual and hearing impairments received a score of 0, those with either
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31 135 vision or hearing impairment received a score of 1, and those with intact vision and hearing
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33 136 capacities scored 2.
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38 137 5) Psychology: It was measured by the 30-item Geriatric Depression Scale (GDS-30) with a total
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40 138 score range of 0–30²⁶. Scores from 0 to 10 represent an intact psychological (score of 2), scores
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42 139 from 11 to 20 represent mild depression (score of 1), and scores from 21 to 30 represent moderate
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44 140 to severe depression (score of 0).
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48 141 For each of the five components, participants were scored either 0 (representing severe decline), 1
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50 142 (representing mild decline), or 2 (representing intact IC). The total score of IC ranged from 0–10;
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52 143 higher scores indicated better performance.
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56 145 *Adverse outcomes*
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9 146 Physical function was assessed as activities of daily living (ADL) and instrumental activities of
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11 147 daily living (IADL). The list of activities consisted of 14 items (eating, grooming, dressing,
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13 148 transferring in and out of bed, bathing, walking inside the house, using the toilet, cooking,
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15 149 managing finances, driving or using public transportation, shopping, walking 250 meters, cutting
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17 150 toenails, and climbing stairs) and a participant's performance for each item was classified as
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19 151 independent, partially dependent, or completely dependent. Those with one or more impaired ADL
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21 152 or IADL functions were defined as disabled. Frailty was assessed using a frailty index, derived
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23 153 from the standard Comprehensive Geriatric Assessment (CGA) instrument (FI was primarily based
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25 154 on six domains: demographic characteristics, physical health, physical functions, living behavior
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27 155 and social functions, mental health, and cognitive functions)²⁷. Frailty was defined by a score of
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29 156 ≥ 0.25 ²⁸. Fractures were defined as a self-reported history of spontaneous fractures occurring in
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31 157 the past two years and falls were defined as those that occurred twice in the past year. Immobility
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33 158 was self-reported.
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4243 160 *Bias*
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46 161 A door-to-door survey was conducted by formally trained interviewers using the CGA to ensure
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48 162 homogeneous reporting. Quality control procedures included regular field supervision and daily
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50 163 review of collected data. EpiData was used to establish the database and input and automatically
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52 164 verify the data.
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Study size

The sample size was estimated to measure the prevalence of IC decline in older adults. Assuming an IC decline prevalence of approximately 30% with a precision margin of 2%, the estimated sample size was 2,016. Assuming a 15% refusal or absence, we estimated a sample size adjusted to 2,372.

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Statistical methods

All statistical analyses were performed using SPSS (Chicago, IL, USA, version 11.0). Count data were expressed as percentages. Chi-square tests, t-tests, and one-way analysis of variance were performed. Those with a P-value less than 0.05 were included in the multivariable model. The weighted percentages were determined using the national standard population composition ratio based on the Sixth National Census (2010). A forward stepwise logistic regression was conducted to explore the association between the included factors and IC decline or between IC decline and adverse outcomes. A P-value of < 0.05 was considered statistically significant.

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Patient and public involvement

Patients and the public were not involved in the planning and design of this study.

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Results

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3 185 Of the total 5,823 older adults, the average IC score was 9.14 ± 1.304 , the median (IQR) score was
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5 186 10(1), and 2,506 had IC decline, yielding a prevalence of 43.0% (weighted 39.9%). A total of
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7 187 3,317 (57.0%), 1,512 (26.0%), 636 (10.9%), 271 (4.7%), 75(1.3%), and 12 (0.2%) participants
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9 188 showed decline in 0, 1, 2, 3, 4, and 5 domains, respectively. The prevalence of IC decline was
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11 189 higher in women than in men (43.0% vs. 36.7%, $P = 0.004$). The prevalence of IC decline among
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13 190 older adults in rural areas was higher, by 1.36 times than in urban areas ($P < 0.001$). The prevalence
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15 191 of IC decline increased with age, with the highest decline observed in individuals aged ≥ 80 years
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17 192 (66.6%) and the lowest in those aged 60–64 years (28.6%; $P < 0.001$; Table 1). The number of
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19 193 participants with decline in the locomotion, cognition, vitality, sensory, and psychological domains
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21 194 was 1,039 (17.8%), 646 (11.1%), 735 (12.6%), 824 (14.2%), and 713 (12.2%), respectively. For
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23 195 each domain, the prevalence was higher in females and those in rural areas, and increased with
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25 196 age, although there was no association between psychological domain and age (Table S2).

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31 197 We observed differences in the prevalence of IC decline among the six regions: 57.7% in Western
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33 198 China, 38.3% in Northern China, 33.7% in Northwest China, 36.1% in Middle China, 16.9% in
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35 199 Eastern China, and 19.8% in Northeast China (Figure 1A). The prevalence of IC decline was higher
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37 200 in northern than southern regions (46.9% vs. 36.7%, $P < 0.001$; Figure 1B). The IC score decreased
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39 201 in older age groups (9.53 ± 0.88 for the 60–64 years age group, 49.37 ± 1.06 for the 65–69 years age
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41 202 group, 9.18 ± 1.22 for the 70–74 years age group, 8.96 ± 1.39 for the 75–79 years age group,
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43 203 8.35 ± 1.73 for the 80 years and over age group ($P < 0.001$; Figure 1C) and was higher in men than
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45 204 in women (9.24 ± 1.19 vs. 9.06 ± 1.38 , $P < 0.001$; Figure 1D).

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51 205 Next, we observed the prevalence of IC decline in different regions according to geography, sex,
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53 206 and age. In urban areas, the weighted prevalence of IC decline differed across the six regions, with

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3 207 western urban regions showing the highest rates and eastern urban regions showing the lowest
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5 208 rates: 43.1% in Western China, 36.1% in Middle China, 33.7% in Northwest China, 30.7% in
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8 209 Northern China, 19.8% in Northeast China, and 11.8% in Eastern China. Older adults living in
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10 210 rural areas included those residing in Beijing and Chengdu, and the prevalence of IC decline was
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12 211 higher in Chengdu than in Beijing (74.1% vs. 47.2%, $P < 0.001$). The prevalence of IC decline
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14 212 among the six regions was different when analyzed according to sex and age, with western regions
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16 213 showing the highest rate in both genders, in those aged < 75 years, and those aged ≥ 75 years; the
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18 214 eastern regions showing the lowest rates in both genders and those aged < 75 years; and east-north
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20 215 regions showing the lowest rates in those aged ≥ 75 years ($P < 0.001$; Figure 2).
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25 216 When comparing socio-psychological factors, chronic diseases, and geriatric syndromes, a high
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27 217 prevalence of IC decline was observed in illiterate participants ($P < 0.001$), those with low income
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29 218 ($P < 0.001$), who were unmarried ($P < 0.001$), did not exercise ($P < 0.001$), consumed less meat
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31 219 diet ($P < 0.001$), and consumed alcohol ($P = 0.043$). Those with chronic diseases such as coronary
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33 220 heart disease ($P < 0.001$), stroke ($P < 0.001$), kidney disease ($P = 0.002$), chronic obstructive
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35 221 pulmonary disease ($P < 0.001$), and osteoarthritis ($P < 0.001$), as well as geriatric syndromes ($P <$
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37 222 0.001) had a higher prevalence of IC decline, while there was a lower prevalence in older adults
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39 223 without diabetes ($P = 0.044$; Table S3). The prevalence of IC decline among individuals with ≥ 5
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41 224 chronic diseases was approximately two times higher than among individuals without chronic
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43 225 disease (62.5% vs. 30.9%, $P < 0.001$).
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49 226 With IC decline as the dependent variable and the above factors as independent variables, forward
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51 227 logistic analysis showed that older age ($P < 0.001$), northern region ($P < 0.001$), low education (P
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53 228 < 0.001), being unmarried ($P < 0.001$), low income ($P < 0.001$), less exercise ($P = 0.003$), less meat
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3 229 intake ($P = 0.003$), insomnia ($P < 0.001$), memory decline ($P < 0.001$), urinary incontinence ($P =$
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5 230 0.001), constipation ($P = 0.001$), slowness ($P < 0.001$), chronic obstructive pulmonary disease (P
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7 231 < 0.001), and osteoarthritis ($P < 0.001$) were independently associated with IC decline in older
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10 232 adults (Table 2).

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13 233 We further compared the frequency of adverse clinical outcomes between non-IC decline and IC
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15 234 decline groups. Participants with IC decline were much more likely to be frail (22.2% vs. 1.2%, P
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17 235 < 0.001), disabled (15.0% vs. 1.0%, $P < 0.001$), and have falls (7.9% vs. 1.8%, $P < 0.001$), fractures
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19 236 (4.7% vs. 2.2%, $P < 0.001$), and be immobile (20.4% vs. 3.4%, $P < 0.001$). Logistic regression
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21 237 showed that, after adjustment for age, sex, area, district, marriage, education, waist-hip ratio,
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23 238 smoking, alcohol consumption, exercise, income, and chronic diseases, IC decline was
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25 239 independently associated with risks of frailty (adjusted OR = 19.021, $P < 0.001$), disability
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27 240 (adjusted OR = 8.611, $P < 0.001$), falls (adjusted OR = 3.053, $P < 0.001$), fractures (adjusted OR
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29 241 = 1.656, $P = 0.003$), and immobility (adjusted OR = 4.403, $P < 0.001$; Table 3).
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36 37 38 243 **Discussion**

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41 244 In this nationally representative population based cross-sectional study, the weighted prevalence
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43 245 of IC decline was as high as 39.9% in community-living Chinese older adults aged ≥ 60 years,
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45 246 which is approximately five times higher than the prevalence of frailty in the same population²⁹.
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47 247 The frequency of participants with a decline in IC domains varied from 11.1% (cognition) to 17.8%
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49 248 (locomotion). These findings highlight the need to focus on functional trajectories rather than the
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51 249 traditional disease-centered approach. However, well-established concepts such as frailty (which
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53 250 is related as an increasingly problematic consequence of population aging), threaten the
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3 251 sustainability of healthcare resources as most people seek healthcare attention only when they are
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5 252 at their worst health state. Furthermore, studies have reported that current integrated care models
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8 253 have not significantly reduced healthcare utilization nor consistently reduced mortality³⁰. Thus,
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10 254 healthcare model such as ICOPE with IC as its core of may support the modernization of current
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12 255 healthcare systems and at the same time be more personalized. Results of ongoing ambitious
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14 256 INSPIRE study conducted in Europe which is based on the ICOPE model³¹ will have strong
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17 257 implications for the effectiveness of the IC approach.
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20 258 Our study demonstrated that the prevalence of IC decline among participants was higher in
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22 259 northern than southern regions of China. Furthermore, there were differences in the prevalence of
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24 260 IC decline among the six regions, which was consistent with previous studies in which the
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27 261 incidence of frailty³² and prevalence of disability²⁰ was more common in the north than the south,
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29 262 indicating the importance of implementing the ICOPE protocol, especially in northern China. We
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31 263 found that the IC score decreased in older age groups, while longitudinal studies showed that the
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34 264 effect of age on the incidence of ADL dependency was modified by IC¹⁵.
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37 265 Logistic regression showed that factors such as age, region, low education, unmarried status, low
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39 266 income, less exercise, less meat intake, insomnia, memory loss, urinary incontinence, constipation,
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41 267 slowness, chronic obstructive pulmonary disease, and osteoarthritis were independently associated
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44 268 with IC decline in older adults, demonstrating that efforts to develop strategies and health policies
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46 269 to identify and manage modifiable variables are urgently required. A longitudinal study in New
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48 270 Zealand showed that neighborhood environments and IC interact to affect the quality of life in
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50 271 older persons³³. Since the above factors are independently associated with an individual's IC,
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53 272 multidomain and complex interventions provide a better option for the prevention and
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3 273 management of IC decline. Accordingly, the WHO recommends screening using instruments such
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5 274 as the ICOPE screening tool as the first step at the primary care level followed by a suitable care
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8 275 plan^{3,4,34}.

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11 276 We demonstrated that after adjusting for sociodemographic variables, age-related factors, and
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13 277 chronic conditions, IC decline was independently associated with risk of frailty, disability, falls,
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15 278 fractures, and immobility, which is in line with the finding that IC predicted the incidence of loss
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17 279 of ADLs and IADLs ¹⁵, and further indicates that evaluations of IC implementation may be
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19 280 extremely important to avoid further deterioration (which could be a severe frailty state). The term
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21 281 frailty refers to health deficits of an aging individual while IC emphasizes on positive health
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23 282 aspects, therefore, IC may be considered as an evolution of frailty in certain respects ³⁵. It is also
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25 283 noteworthy that the World Report on Ageing and Health proposes the concept of IC as central for
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27 284 healthy aging ⁴, thus, the concept of IC could serve as a bridge between geroscience and healthy
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29 285 aging ¹⁴. Furthermore, an IC approach has the benefit of tracing trajectories for progression to
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31 286 adverse clinical outcomes such as frailty and disability, and testing the effectiveness of
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33 287 interventions implemented at the individual level. Thus, an IC model is of great significance for
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35 288 facing the unmet needs of older adults.

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41 289 This study has several limitations. First, the primary limitation is being unable to establish
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43 290 causality due to the cross-sectional design. Further longitudinal studies with a larger sample size
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45 291 are urgently required. Second, vitality was defined by BMI instead of specific nutritional
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47 292 assessment, which may have affected some of the results. Since most of the diabetic patients in
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49 293 our study had a higher BMI, this could explain the lower IC decline in participants with diabetes.
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51 294 Third, we used a composite total score instead of a weighted score, so further statistical approaches
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3 295 should be conducted to compute IC scores. Fourth, self-reporting for hearing impairment may
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5 296 misestimate hearing loss (although WHO recommends whisper test for assessing hearing loss).
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8 297 Fifth, 1,040 participants who were unable to complete the IC assessment were excluded in this
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10 298 study. The excluded participants who were older and frailer, had more chronic diseases, and lower
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12 299 scores in each domain (Table S1), which may have misestimated the prevalence of IC decline.
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15 300 To the best of our knowledge, this study is the first nationally representative large sample of
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17 301 population-based older people focusing on IC in China. Most of the components of IC were
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19 302 assessed using unified measured performance tests, thus avoiding response or interviewer bias.
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21 303 Standardized protocols, as well as regularly and randomly performed internal quality checks of the
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23 304 data, were used to avoid the quality disadvantage of the multi-center design.
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28 305 In conclusion, this study provided a preliminary understanding of the IC status of Chinese older
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30 306 adults. Our results indicate that efforts promoting IC to delay functional dependence should focus
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32 307 on negative social factors, poor lifestyle, chronic diseases, and geriatric syndromes. This study
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34 308 also validated the IC concept in Chinese population. In fact, China has already implemented the
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36 309 ICOPE approach into clinical practice and launched a pilot multi-center study called “China Aging,
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38 310 Resilience and Intrinsic Capacity Study (CARICS)” to identify and manage IC decline to improve
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40 311 well-being among community-living older adults. We hope that this approach of IC will be a
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42 312 fundamental tool towards healthy ageing worldwide.
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40 330 approved the final manuscript submitted for publication.

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460 Captions for Tables and Figures

461 Table 1. Prevalence of declines in intrinsic capacity in older adults by sex, area, and age

462 Table 2. Stepwise forward logistic regression for associated factors with intrinsic capacity decline

463 Table 3. Multivariate logistic regression analysis (forward method) for intrinsic capacity decline
464 associated with risk of adverse clinical outcomes

465 Figure 1. Intrinsic capacity in different regions, age, and sex groups. (A) The comparison of the
466 weighted prevalence of IC decline among the six regions of China (Chi-square test, $p < 0.01$). (B)
467 The comparison of the weighted prevalence of IC decline between North China and South China
468 (Chi-square test, $p < 0.01$). (C) The comparison of the intrinsic capacity score among different age
469 groups (One-way ANOVA, $p < 0.01$). (D) The comparison of the intrinsic capacity score between
470 males and females (t-test, $p < 0.01$). Abbreviations: ANOVA, analysis of variance; IC, intrinsic
471 capacity; IC decline, Intrinsic capacity decline.

472 Figure 2. The weighted prevalence of declines in intrinsic capacity in community-dwelling older
473 adults living in the urban area (A1), rural area (A2), male (B1), female (B2), <75 ys (C1) and ≥ 75
474 ys (C2). All were analyzed using the Chi-square test, $p < 0.01$.

475 Table S1. Comparison of characteristics between included and excluded participants

476 Table S2. Prevalence of each intrinsic capacity domain declined by sex, area, and age

477 Table S3. The effect of social factors, lifestyle and chronic conditions on intrinsic capacity decline

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Table 1. Prevalence of intrinsic capacity decline in older adults by sex, area, and age

	Total n	Intrinsic capacity decline n (%)	Weighted (%)	Number of Declined Domains					
				0	1	2	3	4	5
All sample	5823	2506(43.0)	39.9	3317(57.0)	1512(26.0)	636(10.9)	271(4.7)	75(1.3)	12(0.2)
Sex*									
Male	2518	1030(40.9)	36.7	1488(59.1)	652(25.9)	266(10.6)	81(3.2)	27(1.1)	4(0.2)
Female	3305	1476(44.7)	43.0	1829(55.3)	860(26.0)	370(11.3)	190(5.7)	48(1.5)	8(0.2)
Area*									
Urban	3494	1243(35.6)	32.7	2251(64.4)	868(24.8)	275(7.9)	81(2.3)	18(0.5)	1(0)
Rural	2329	1263(54.2)	50.1	1066(45.8)	644(27.7)	361(15.5)	190(8.2)	57(2.4)	11(0.5)
Age (ys)*									
60-64	1471	428(29.1)	28.6	1043(70.9)	309(21.0)	85(5.8)	30(2.0)	4(0.3)	0(0)
65-69	1179	414(35.1)	34.9	765(64.9)	271(23.0)	100(8.5)	34(2.9)	9(0.8)	0(0)
70-74	1165	515(44.2)	43.6	650(55.8)	337(28.9)	116(10.0)	46(3.9)	16(1.4)	0(0)
75-79	1119	562(50.2)	50.3	557(49.8)	325(29.0)	150(13.4)	62(5.5)	20(1.8)	5(0.4)
≥80	889	587(66.0)	66.6	302(34.0)	270(30.4)	185(20.8)	99(11.1)	26(2.9)	7(0.8)

Note: *P<0.05.

479
480 **Table 2. Stepwise forward logistic regression for associated factors with intrinsic capacity**
481 **decline**

Factors	B	S.E.	Wald	df	Sig	OR	95% CI
Older age	0.647	0.093	48.426	1	<0.001	1.910	1.592-2.291
North region	0.466	0.090	26.993	1	<0.001	1.594	1.337-1.901
Low education	0.890	0.143	38.657	1	<0.001	2.435	1.839-3.223
Unmarried	0.395	0.105	14.157	1	<0.001	1.485	1.209-1.825
Low income	0.388	0.094	16.974	1	<0.001	1.474	1.226-1.773
Less exercise	0.293	0.099	8.690	1	0.003	1.340	1.103-1.628
Less meat intake	0.260	0.089	8.532	1	0.003	1.296	1.089-1.543
Insomnia	0.453	0.095	22.735	1	<0.001	1.572	1.305-1.894
Urinary incontinence	0.680	0.209	10.605	1	0.001	1.974	1.311-2.973
Constipation	0.408	0.126	10.605	1	0.001	1.504	1.175-1.924
Memory decline	0.714	0.083	73.427	1	<0.001	2.043	1.735-2.405
Slowness	0.407	0.102	15.908	1	<0.001	1.502	1.230-1.835
COPD	0.853	0.215	15.758	1	<0.001	2.347	1.540-3.576
Osteoarthritis	0.534	0.095	31.785	1	<0.001	1.706	1.417-2.054
Constant	-2.028	0.104	379.542	1	<0.001	0.132	

482 Note: COPD, chronic obstructive pulmonary disease.

483 The variables not in the equation were sex, living areas, alcohol consumption, coronary heart
484 disease, diabetes, stroke and kidney disease.

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486

Table 3. Multivariate logistic regression analysis (forward method) for intrinsic capacity decline associated with risk of adverse clinical outcomes

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	Model 1			Model 2		
	OR	95% CI	P value	OR	95% CI	P value
Frailty	19.625	14.044-27.423	<0.001	19.021	12.882-28.084	<0.001
Disability	12.628	8.750-18.225	<0.001	8.661	5.925-12.660	<0.001
Fall	3.671	2.699-4.993	<0.001	3.053	2.232-4.177	<0.001
Fracture	1.965	1.448-2.666	<0.001	1.656	1.195-2.295	0.003
Immobility	6.098	4.903-7.584	<0.001	4.403	3.500-5.538	<0.001

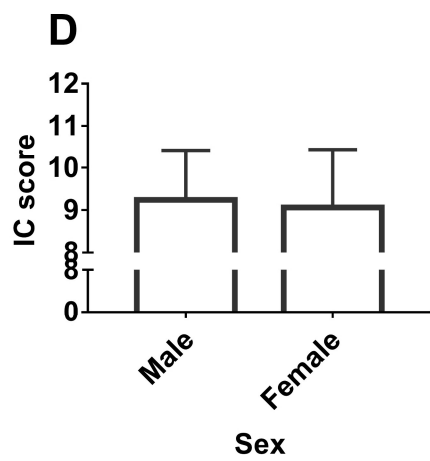
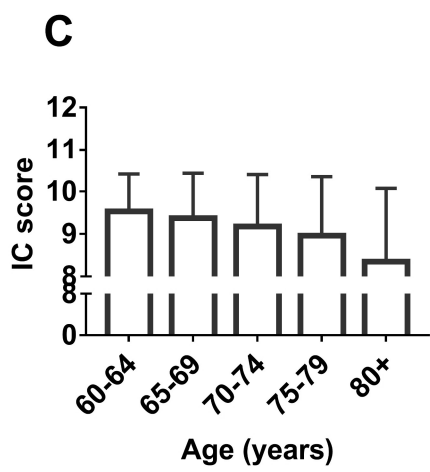
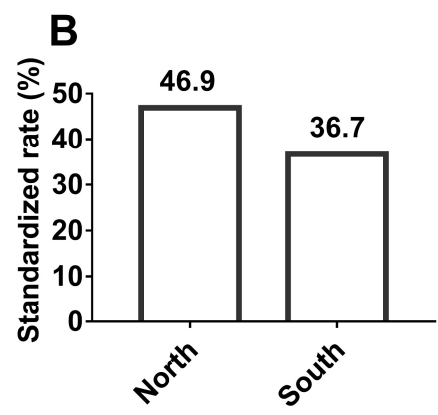
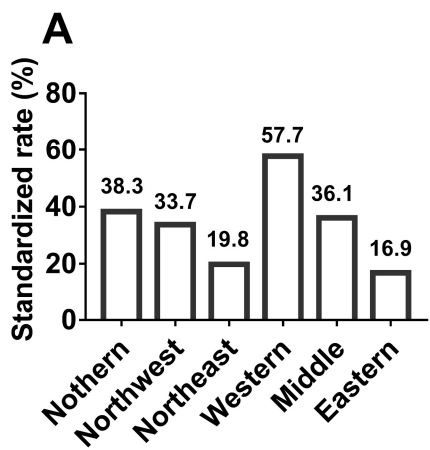
489 Reference: Non-intrinsic capacity decline.

490 Model 1: Adjusted by age, sex, area and district.

491 Model 2: Adjusted by age, sex, area, district, marriage, education, waist hip ratio, smoking,
492 alcohol consuming, exercise, income, and chronic diseases.

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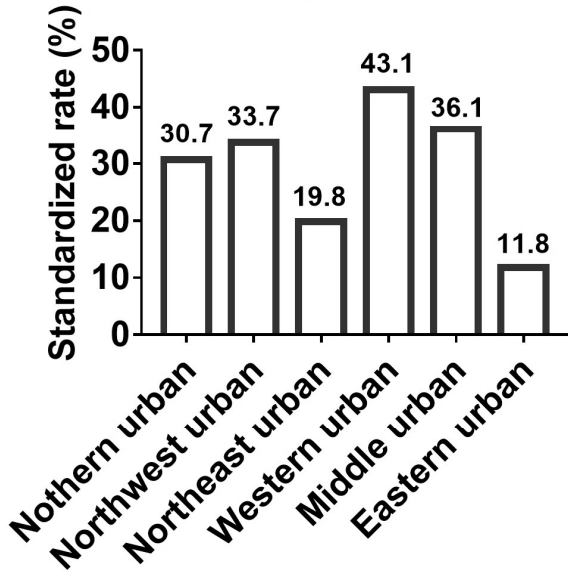
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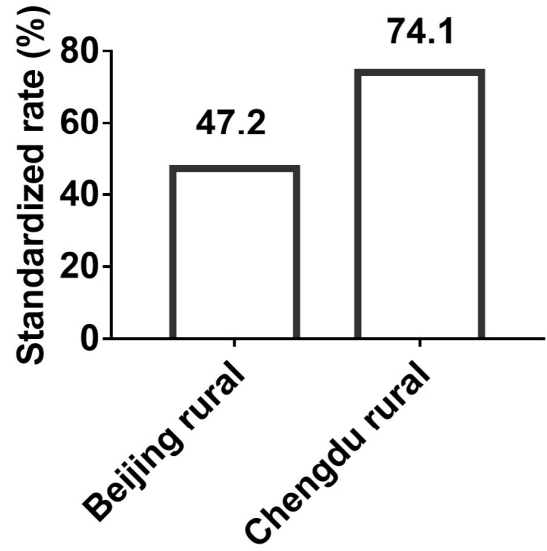
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Urban



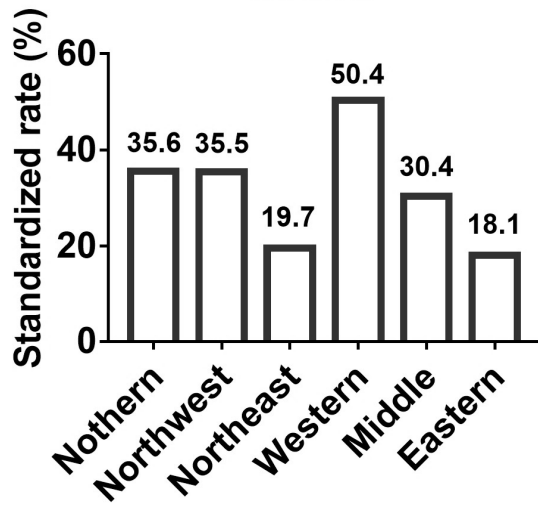
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Rural



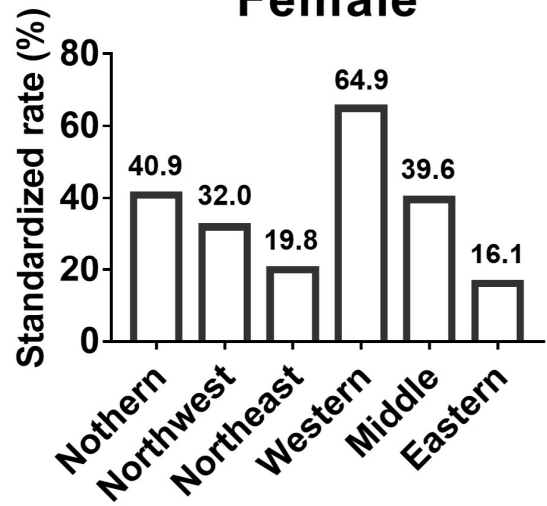
B1

Male



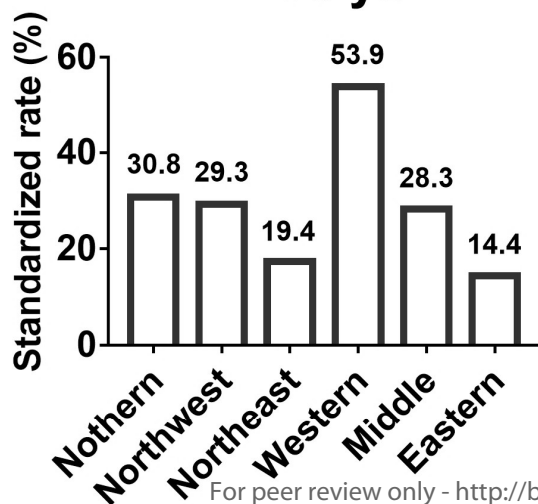
B2

Female



C1

<75 ys



C2

>=75 ys

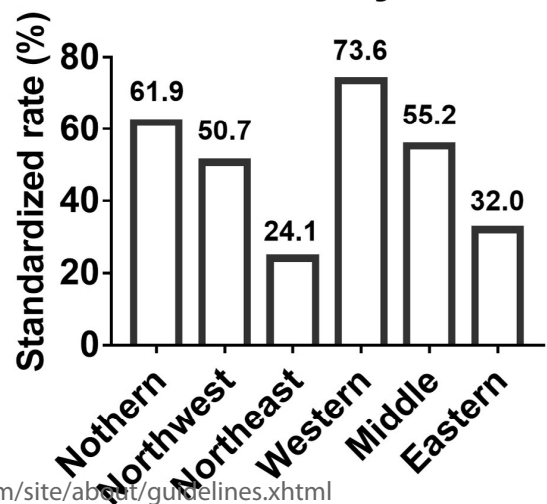


Table S1. Comparison of characteristics between included and excluded participants

	Included participants	Excluded participants	<i>P</i>
Age (ys)	70.86±7.68	72.43±7.37	<0.001
Sex (male) (n, %)	2518(43.2)	450(43.1)	0.934
Education (Illiterate) (n, %)	1047(18.0)	208(20.1)	0.102
Hypertension (n, %)	3835(65.9)	744(71.3)	0.001
CHD (n, %)	1168(20.1)	291(28.0)	<0.001
Diabetes (n, %)	862(14.8)	186(17.9)	0.011
Stroke (n, %)	579(9.9)	139(13.4)	0.001
Kidney disease	259(4.4)	50(4.8)	0.607
COPD	205(3.5)	49(4.7)	0.061
Osteoporosis	1597(27.4)	398(38.8)	<0.001
Immobility	624(10.7)	189(18.2)	<0.001
Frailty index	0.15±0.08	0.20±0.12	<0.001
Locomotion score	1.77±0.53	1.26±0.92	<0.001
Psychological score	1.86±0.38	1.88±0.36	0.122
Cognition score	1.85±0.46	1.85±0.47	0.913
Vitality score	1.82±0.51	1.88±0.42	<0.001
Sensory score	1.84±0.42	1.76±0.47	<0.001

Abbreviations: CHD, coronary heart disease; COPD, chronic obstructive pulmonary disease.

Table S2. Prevalence of each intrinsic capacity domain declined by sex, area, and age

	Total	Locomotion	Cognition	Vitality	Sensory	Psychology
All sample	5823	1039(17.8)	646(11.1)	735(12.6)	824(14.2)	713(12.2)
Sex						
Male	2518	372(14.8)*	227(9.0)*	338(13.4)	371(14.7)	247(9.8)*
Female	3305	667(20.2)	419(12.7)	397(12.0)	453(55.0)	466(14.1)
Area						
Urban	3494	481(14.1)*	168(4.8)*	344(9.8)*	417(11.9)*	318(9.1)*
Rural	2329	548(23.5)	478(20.5)	391(16.8)	407(17.5)	395(17.0)
Age (ys)						
60-64	1471	106(7.2)*	72(4.9)*	116(7.9)*	114(7.7)*	177(12.0)
65-69	1179	129(10.9)	90(7.6)	123(10.4)	131(11.1)	136(11.5)
70-74	1165	197(16.9)	123(10.6)	141(12.1)	166(14.2)	144(12.4)
75-79	1119	256(22.9)	158(14.1)	154(13.8)	210(18.8)	138(12.3)
≥80	889	351(39.5)	203(22.8)	201(22.6)	203(22.8)	118(13.3)

Note: Data were expressed as n (%); *P<0.05

Table S3. The effect of social factors, lifestyle and chronic conditions on intrinsic capacity decline

	Total	IC decline, n (%)	Weighted (%)	χ^2	P
Social factors					
Education	5823				
Illiterate	1047	724(69.1)	67.7	355.086	<0.001
Not illiterate	4776	1782(37.3)	34.9		
Monthly income	5665				
<2000 Yuan	2658	1408(53.0)	49.6	227.561	<0.001
≥2000 Yuan	3007	996(33.1)	30.0		
Marital status	5818				
Married	4493	1738(38.7)	35.8	151.541	<0.001
Unmarried	1325	765(57.7)	56.8		
Lifestyle					
Exercise	5808				
Yes	4594	1779(38.7)	36.1	168.600	<0.001
No	1214	722(59.5)	55.0		
Meat intake	5823				
Usually	3369	1322(39.2)	35.9	46.925	<0.001
Less	2454	1184(48.2)	45.8		
Alcohol consumption	5823				
Yes	4503	600(45.5)	40.7	4.081	0.043
No	5823	1906(42.3)	39.6		
Smoking	1320				
Yes	1658	722(43.5)	38.7	0.241	0.623
No	4165	1784(42.8)	40.5		
Chronic disease					
Hypertension	5823				
Yes	2688	1127(41.9)	39.0	2.505	0.113
No	3135	1379(44.0)	40.7		
CHD	5823				
Yes	1168	559(47.9)	46.0	13.823	<0.001
No	4655	1947(41.8)	38.5		
Diabetes	5823				
Yes	862	344(39.9)	36.6	4.041	0.044
No	4961	2162(43.6)	40.5		
Stroke	5823				
Yes	579	327(56.5)	53.3	47.323	<0.001
No	5244	2179(41.6)	38.5		
Kidney disease	5823				
Yes	259	136(52.5)	50.6	9.907	0.002
No	5564	2370(42.6)	39.4		
COPD	5823				
Yes	205	140(68.3)	66.7	55.288	<0.001
No	5618	2366(42.1)	39.0		

1						
2						
3	Liver disease	5823				
4	Yes	253	107(42.3)	40.0	0.062	0.803
5	No	5570	2399(43.1)	38.7		
6						
7	Osteoarthritis	5823				
8	Yes	1597	855(53.5)	51.2	98.993	<0.001
9	No	4226	1651(39.1)	35.9		
10						
11	Cancer	5823				
12	Yes	148	63(42.6)	39.7	0.013	0.909
13	No	5675	2443(43.0)	39.9		
14	Geriatric syndrome					
15	Insomnia	5823				
16	Yes	1427	830(58.2)	56.5	176.113	<0.001
17	No	4396	1676(38.1)	34.9		
18	Memory decline	5823				
19	Yes	2629	1450(55.2)	52.6	286.447	<0.001
20	No	3194	1056(33.1)	30.2		
21	Urinary incontinence	5823				
22	Yes	257	198(77.0)	76.3	126.654	<0.001
23	No	5566	2308(41.5)	38.5		
24	Constipation	5823				
25	Yes	738	430(59.1)	56.6	87.043	<0.001
26	No	5095	2076(40.8)	37.8		
27	Slowness	3306				
28	Yes	688	367(53.3)	50.2	54.008	<0.001
29	No	2618	991(37.9)	35.1		

Abbreviations: **IC**, **intrinsic capacity**; ADL, activities of daily living; IADL, instrumental activities of daily living; CHD, coronary heart disease; COPD, chronic obstructive pulmonary disease.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1,2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-8
Bias	9	Describe any efforts to address potential sources of bias	9
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	10
		(b) Describe any methods used to examine subgroups and interactions	10
		(c) Explain how missing data were addressed	N/A
		(d) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(e) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	12
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-12
		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.