

Rural-urban inequalities in poor self-rated health, functional disabilities and depression among Chinese older adults: Evidence from the China Health and Retirement Longitudinal Study 2011 and 2015

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1 **Rural-urban inequalities in poor self-rated health, functional**
2 **disabilities and depression among Chinese older adults: Evidence**
3 **from the China Health and Retirement Longitudinal Study 2011 and**
4 **2015**

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24

25 **Abstract**

26 **Background:** The demand for healthcare and social services increases with the aging
27 of the population and functional disabilities among older adults. Rural-urban
28 inequalities in health have not been extensively studied previously from the national
29 perspective, especially after classifying the effects of Hukou (household registration
30 system in China) and residence. This study investigates rural-urban inequalities in
31 prevalence of poor self-rated health, functional disabilities and self-reported
32 depression among Chinese older adults and analyses determinants of rural-urban
33 inequalities in self-reported health outcomes.

34 **Methods:** The data originate from the China Health and Retirement Longitudinal Study
35 (CHARLS), which started in 2011 and collects data every two years, a representative
36 sample in 28 provinces in China. Older adults aged 60 years and above in CHARLS
37 2011 and CHARLS 2015 were studied. Sociodemographic factors were studied,
38 including age, sex, marital status, living arrangement, living near children,
39 educational level and income. Self-Rated Health (SRH) was assessed with a single
40 question. Basic Activities of Daily Living (BADLs) and Instrumental Activities of
41 Daily Living (IADLs) were used to measure self-reported functional abilities. The
42 10-item version of the Center for Epidemiologic Studies Depression Scale was used to
43 measure self-reported depression.

44 **Results:** Rural respondents had poor socioeconomic status and higher prevalence of
45 poor SRH, functional disabilities and depression than urban respondents. The levels of
46 functional disabilities, both BADLs and IADLs, were similar in 2011 and 2015, while
47 the prevalence of poor SRH and self-reported depression were lower in 2015, both
48 among rural and urban respondents. Impairments increased with age, and appeared at
49 younger age among rural respondents compared to urban respondents. Being female,

50 unmarried, with low educational level and low income increased the odds ratios of
51 reporting poor SRH, functional disabilities and depression. Living arrangement and
52 living near children did not have significant impacts on health outcomes.

53 **Conclusions:** Rural-urban inequalities in poor SRH, functional disabilities and
54 depression were mainly related to educational level and income.

55

56 **Key words:** China; depression; functional ability; health inequalities; older adults;
57 rural-urban; self-rated health; social determinants of health

58

59 **Background**

60 The proportion of older adults in China is increasing [1, 2]. By the end of 2018, there
61 were 249 million people aged 60 and over years in China, accounting for 17.9% of the
62 total population, and the population aged 65 and over reached 158 million. Life
63 expectancy of Chinese people has been continuously increasing from 35.5 years in
64 1949 to 77.0 years in 2018 [3]. This may have a major impact on the coping capacities
65 of China's health and social care systems.

66 Nearly 60% of the Chinese older adults live in rural areas [4]. Rural areas are less
67 technically and economically developed and have large scale of empty nest older
68 adults [5]. Compared to older adults in urban areas, those in rural areas have lower
69 socioeconomic status [6] and less access to health services and social support [5] and
70 report worse health status [7]. Disparities in living conditions between rural and urban
71 areas might influence health outcomes of older adults. In addition, the household
72 registration (Hukou) system in China, which classifies each person into rural or an
73 urban citizen, is a major means of monitoring population mobility and determining

74 eligibility for state-provided services and welfare [8]. Citizens' interests and rights,
75 such as education, health insurance, pension insurance, housing and employment,
76 welfare and social security are determined by Hukou [9]. As this differs between rural
77 and urban areas, it results in significant rural-urban inequality in health outcomes [10,
78 11]. However, previous studies rarely take population mobility into consideration to
79 estimate rural-urban inequalities in self-reported health outcomes among Chinese
80 older adults.

81 Furthermore, living alone or not [12-14] and the proximity to children could influence
82 the older adults' health [13, 15]. Studies have shown that close proximity to children
83 can be similar to co-residence [16], whereas others see any kind of non-co-residence
84 as a sign of weakened inter-generational ties [17].

85 Different dimensions of health, such as functional abilities [18] and psychological
86 health [19] are important for an individual's well-being [20]. Functional abilities
87 deteriorate as people become older [21].

88 Determinants of rural-urban inequalities in health outcomes are important to
89 investigate. Socioeconomic factors may be important determinants of health
90 disparities among rural and urban older adults [22, 23]. Few studies have compared
91 the relationship between socioeconomic factors and self-reported health outcomes in
92 Chinese older adults and examined whether rural-urban inequalities have changed
93 over years.

94 The present study investigates rural-urban inequalities in prevalence of poor self-rated
95 health, functional disabilities and self-reported depression among Chinese older adults
96 and analyses determinants of rural-urban inequalities in those self-reported health

97 outcomes.

98 **Methods**

99 **Data sources**

100 The China Health and Retirement Longitudinal Study (CHARLS) is a nationally
101 representative household survey of the Chinese population [24]. It covers many
102 aspects across the interviewee's lifetime, including household information, health
103 status and functioning, health care and insurance, income, retirement and pension.

104 The CHARLS survey was conducted by the National School of Development (China
105 Centre for Economic Research) of Peking University. The survey used a face-to-face
106 computer-assisted personal interview. All interviewees were required to sign informed
107 consent. Ethical approval for the data collection in CHARLS was granted by the
108 Ethical Review Committee of Peking University (IRB00001052–11015).

109 The baseline survey was conducted between June 2011 and March 2012 covering 28
110 provinces, 150 counties/districts, 450 communities, and 17,708 respondents (age \geq 45
111 years) from 10,257 households. Two follow-up interviews were conducted in 2013
112 and 2015. The sample was collected on a multi-stage probability-proportional-to-size
113 technique, with county-level units stratified by region and then by urban districts
114 (urban areas) or rural counties (rural area) [25] and per capita gross domestic product,
115 with an overall response rate of 80.5% at the baseline [24]. Data are publicly
116 available.

117 Our study used the data of CHARLS 2011 and CHARLS 2015 to investigate
118 prevalence of poor self-rated health (SRH), impaired Basic Activities of Daily Living

119 (BADLs) and impaired Instrumental Activities of Daily Living (IADLs) and
120 self-reported depression among rural and urban Chinese older adults aged 60 years
121 and above. There were 7,638 respondents in CHARLS 2011 and 10,185 respondents
122 in CHARLS 2015, which were included in our study.

123 **Demographic indicators**

124 In order to avoiding misclassification of individuals in rural and urban areas, we
125 combined the information on Hukou with information on living areas. Respondents,
126 who have rural Hukou (agricultural household) and live in rural areas, were identified
127 as rural respondents. Respondents, who have urban Hukou (non-agricultural
128 household) and live in urban areas, were considered as urban respondents.

129 Age was respondent's age in years at the time of the current wave's interview,
130 calculated from the interview year and month minus the respondent's birth year and
131 month and then divided into different age groups 60-64, 65-69, 70-74, 75-79, 80-84,
132 85-89 and 90+ years. Marital status was dichotomized into married and unmarried
133 (i.e., widowed, never married, divorced or separated). Living arrangement was
134 categorized in to not living alone or living alone.

135 In CHARLS, whether the respondent has a child who lives in the same city or county
136 was asked. If respondents have any child co-resides or any non-co-resides child lives
137 in the same city or county was identified as "living near children". If respondents
138 have living children but their children do not co-reside nor live in the same city or
139 county was recoded as "living near children". The respondent does not have any
140 children was categorized as "No child".

141 **Socio-economic indicators**

142 Educational level was categorized into below primary school, primary school, middle
143 school, high school, and college and above. An individual's annual income was
144 assessed by dividing the total household annual income by the number of persons
145 living in the family within the last half-year, regardless of age and employment status
146 [25]. Total household annual income is the sum of all income at the household level
147 including income from earnings, capital income, and pension income, income from
148 government transfers, other income and the total income from other household
149 members. Respondents were then ranked from lowest to highest by their annual
150 income and divided into five groups of equal size: in CHARLS 2011, the lowest
151 income group had an income below 610 Chinese Yuan (CNY); the second group from
152 611 to 2,100 CNY; the third group from 2,101 to 5,325 CNY; the fourth group from
153 5,326 to 12,067 CNY; the fifth and highest income group 12,068 CNY and above. In
154 CHARLS 2015, the lowest income group had an income below 500 CNY; the second
155 group from 501 to 1,169 CNY; the third group from 1,170 to 3,599 CNY; the fourth
156 group from 3,600 to 13,339 CNY; the fifth and highest income group 13,440 CNY
157 and above.

158 Respondents with missing data on Hukou, sex, marital status, living arrangement and
159 education level were excluded. We also excluded the respondents with rural Hukou
160 and live in urban areas and the respondents with urban Hukou and live in rural areas.
161 See the distribution of respondents with different Hukou in rural and urban areas in
162 Supplementary Table S1. The final samples used for analyses were 6,048 respondents
163 in CHARLS 2011 and 7,396 respondents in CHARLS 2015. (Figure 1)

164 **Outcome variables**

165 Poor Self-Rated Health (SRH), impaired Basic Activities of Daily Living (BADLs),
166 impaired Instrumental Activities of Daily Living (IADLs) and self-reported
167 depression are health outcomes.

168 **Self-Rated Health (SRH)**

169 SRH was measured by a single question. CHARLS adopted two 5-point scales for
170 self-reported general health, which were randomly assigned to participants to examine
171 any effects of central tendency bias: respondents either rate their health from
172 “excellent” to “very good”, “good”, “fair”, and “poor” or from “very good” to “good”,
173 “fair”, “poor” and “very poor”. Respondents were asked their health status twice,
174 once in the beginning of the health module with one scale and again in the end of the
175 health module with another scale. This study focused on persons with worse health
176 outcomes, so the scale ranging from 1 for “Very Good” to 5 for “Very poor” was used.
177 Poor or very poor health was recoded as poor health, others are not poor health.

178 **Basic Activities of Daily Living (BADLs)**

179 Katz Activities of Daily Living Scale [26] was used to assess BADLs in CHARLS,
180 which is a 6-item summary with dressing, bathing and showering, eating, getting in
181 and out of bed, using the toilet and controlling urination and defecation. Respondents
182 were asked “Do you have any difficulty with the following basic activity of daily
183 living?” With the scoring system used in CHARLS, each item was scored as
184 following: 1 score signified “do not have any difficulty”, 2 scores signified “have
185 difficulties but still can do it”, 3 scores signified “have difficulties and help is needed”,

186 and 4 scores signified “cannot complete it”. The Chinese version of the scale has been
187 extensively tested and has been shown to yield reliable and valid responses [27].
188 Score of BADLs was calculated by the sum of all items. Having any difficulty with an
189 activity (total score of BADLs>6) was identified as “impaired BADLs”.

190 **Instrumental Activities of Daily Living (IADLs)**

191 IADLs are measured by the Lawton IADL Scale [28], which is ideal for
192 community-dwelling older adults, as well as those who have been admitted to a
193 hospital, short-term skilled nursing facility, or rehabilitation facility [29]. Performance
194 was examined with 5 items, doing household chores, cooking, shopping, managing
195 money, taking medications [28], which were more complex level of organized human
196 behavior than BADLs [28]. Respondents were asked “Do you have any difficulty with
197 the following instrumental activity of daily living?” With the scoring system used in
198 CHARLS, each item was scored as following: 1 score signified “do not have any
199 difficulty”, 2 scores signified “have difficulties but still can do it”, 3 scores signified
200 “have difficulties and help is needed”, and 4 scores signified “cannot complete it”.
201 The sum score of all items more than 5 scores was categorized as “impaired IADLs”.

202 **Self-reported depression**

203 In CHARLS, the 10-item version of the Center for Epidemiologic Studies Depression
204 Scale (CES-D-10) was used to measure respondents’ self-reported depression.

205 CES-D-10 is the sum of the 10 self-reported questions, after reverse coding.

206 Additionally, the scales for each of the ten questions were adjusted so that the anchors
207 were 0 to 3, rather than 1 to 4. CES-D-10 ranges from 0 to 30 with higher scores

208 indicating that the respondent felt more negatively during the past week. Each

209 participant was categorized as having ‘significant’ or ‘mild’ depressive symptoms if
210 the total score of the CES-D-10 was 10 or above [30].

211 **Statistical analysis**

212 Descriptive statistics were presented as mean and standard deviations for numerical
213 variables, or as percentages for categorical variables.

214 Differences of the prevalence of poor SRH, impaired BADLs, impaired IADLs and
215 self-reported depression between the rural and urban respondents were examined for
216 each respective year, by using Chi-square test or Fisher’s Exact test for nominal
217 categorical variables [31] for variables with ordinal explanatory variables. Independent
218 T-test was used to analyze the differences between rural and urban respondents in
219 means of age and income. Multiple logistic regressions were performed to examine the
220 associations between the outcome variables and demographic explanatory variables.

221 All statistical analyses were performed using SAS 9.4.1. The level of significance was
222 specified at 0.05. A Bonferroni adjusted significance level was used in case of
223 multiple tests.

224 **Results**

225 **Individual characteristics**

226 Among older respondents, 72.6% were rural respondents in CHARLS 2011 and 72.8%
227 in CHARLS 2015. Rural respondents were younger than urban respondents. There
228 were more females among rural respondents than urban respondents in 2015 (Table

229 1).

230 Compared to urban respondents, more rural respondents were unmarried. In 2011, 9.5%
231 rural respondents and 13.7% urban respondents lived alone, but 8.9% rural
232 respondents and 8.1% urban respondents in 2015. More respondents did not alone.
233 Fewer respondents lived near their children in 2015 than in 2011.

234 Rural respondents had lower levels of education and income than urban respondents.
235 About two-thirds of the rural respondents had less than primary school, compared to
236 almost one fourth of urban respondents. In 2015, respondents were more educated
237 both among rural and urban respondents. Mean of individual annual income was
238 nearly 4 times as high among urban respondents (18,846 CNY in 2011; 20,979 CNY
239 in 2015) as among rural respondent (4,126 CNY in 2011; 5,294 CNY in 2015).
240 Individual annual income was higher in 2011 than in 2015 (Table 1).

241 **Prevalence of health outcomes**

242 The prevalence of poor SRH and self-reported depression were lower in 2015 than in
243 2011, while prevalence of impaired BADLs and impaired IADLs were higher. The
244 prevalence of impaired IADLs was higher than the prevalence of BADLs among rural
245 and urban respondents in both years. Rural respondents had worse health outcomes
246 than urban respondents. (Figure 2)

247 See Supplementary tables for the prevalence of health outcomes among respondents
248 with different Hukou in rural and urban areas (Table S2) and prevalence of health
249 outcomes among respondents in urban areas with different Hukou (Table S3).

250 **Prevalence of poor SRH**

251 Rural respondents reported higher prevalence of poor self-rated health than urban
252 respondents (Table 2). The prevalence of poor SRH in 2015 was lower than in 2011,
253 declined from 39% to 30% among rural respondents and from 24% to 18% among
254 urban respondents.

255 There was a significant difference of reporting poor health between rural and urban
256 respondents among each age group. The prevalence of poor SRH was significantly
257 increased with increasing age. Respondents at older age had higher prevalence of poor
258 SRH. Compared to male respondents, more females reported poor SRH, especially
259 among rural respondents. There was higher prevalence of poor SRH among the
260 respondents who were unmarried, with lower educational level and lower income.

261 **Prevalence of impaired BADLs**

262 The prevalence of impaired BADLs among the older respondents was slightly higher
263 in 2015 than in 2011 (Table S4). Increasing age was associated with the higher
264 prevalence of BADLs. Compared to urban respondents, the impairments of BADLs
265 appeared at younger age among rural respondents. There was no significant difference
266 in the prevalence of impaired BADLs between rural and urban respondents who were
267 aged 80 years and above. There was higher prevalence of impaired BADLs among
268 females and living alone respondents than males and not living alone respondents. In
269 2011, rural respondents who did not live near children had higher prevalence (32%) of
270 being impaired in BADLs, while only 7% among urban respondents who did not live
271 near children were impaired. However, in 2015, the prevalence of impaired BADLs
272 among rural respondents was 27%, while 15% urban respondents who did not live

273 near children reported impaired BADLs.

274 Groups with higher educational level and higher income level had a lower prevalence
275 in impaired BADLs. There was no significant difference in the prevalence of impaired
276 BADLs between rural and urban respondents within each income group, while
277 excepting the lowest income group in 2015 and the highest income group in both
278 years.

279 **Prevalence of impaired IADLs**

280 The prevalence of impaired IADLs among the older respondents was similar in 2011
281 and 2015 (Supplement Table S5). Increasing age was associated with the higher
282 prevalence of IADLs. Compared to urban respondents, the impairments of IADLs
283 appeared at younger age among rural respondents. There was no significant difference
284 in the prevalence of impaired BADLs between rural and urban respondents who were
285 aged 85 years and above in both years. There was higher prevalence of impaired
286 IADLs among females than males. There was no significant difference between living
287 alone and not living alone. Compared to the respondents who were not live near
288 children, those living near children had higher prevalence of being impaired in IADLs.
289 The respondents did not have any child reported higher prevalence of impaired
290 IADLs.

291 Groups with higher educational level and higher income level had a lower prevalence
292 in impaired IADLs. There was no significant difference in the prevalence of impaired
293 IADLs between rural and urban respondents within each income group, while
294 excepting the lowest income group in 2015 and the highest income group in both
295 years.

296 **Prevalence of self-reported depression**

297 Compared to urban respondents, more rural respondents reported self-reported
298 depression, nearly two times more than urban respondents. (Supplement Table S6)
299 The prevalence of self-reported depression among respondents was lower in 2015
300 than in 2011. The prevalence of self-reported depression was 47.4% in 2011 and was
301 40.5% in 2015 among rural respondents, while it was 27.8% in 2011 and 22.7% in
302 2015 among urban respondents.

303 There was a significant difference of reporting depression between rural and urban
304 respondents within each age group. Depression was significantly associated with
305 increasing age. Respondents at older age had higher prevalence of depression.
306 Respondents living alone, being unmarried, with lower educational level and lower
307 income had a higher risk of reporting depression. Compared to male respondents,
308 more females reported depression, especially among rural respondents. (Supplement
309 Table S6)

310 **Determinants of poor SRH, functional disabilities and self-reported**
311 **depression**

312 After adjusting for age and sex, Hukou-Residence, the difference in level of education
313 and income between rural and urban respondents explained a large part of the
314 differences in health outcomes between rural and urban respondents. Whether living
315 alone or living near children was not significantly related to health outcomes.

316 Table 3 showed that, in Model 1, rural respondents had a higher odds ratio of
317 reporting poor SRH in 2011 (OR=2.05) than in 2015 (OR=2.00). Income and

318 education level were closely related to health outcomes. Adjusted for living
319 arrangement, live near children, educational level and income group, in Model 5, the
320 odds ratio for reporting poor SRH was 1.34 in 2011 and 1.51 in 2015. The difference
321 in level of education and income between rural and urban respondents explained a
322 large part of the differences in health outcomes between rural and urban respondents.

323 For impaired BADLs, in Model 1, rural respondents had higher odds ratio (OR=1.99)
324 of reporting impaired BADLs in 2011 than in 2015 (OR=1.76). Adjusted for living
325 arrangement, live near children, educational level and income group, in Model 5, the
326 odds ratio for reporting impaired BADLs was 1.09 in 2011 and 1.37 in 2015. The
327 difference in level of education and income between rural and urban respondents
328 explained a large part of the differences in health outcomes between rural and urban
329 respondents. (Table 4)

330 For impaired IADLs, in Model 1, rural respondents had higher odds ratio (OR=2.05)
331 of reporting impaired IADLs in 2011 than in 2015 (OR=2.03). Adjusted for living
332 arrangement, live near children, educational level and income group, in Model 5, the
333 odds ratio for reporting impaired IADLs was 1.13 in 2011 and 1.50 in 2015. The
334 difference in level of education and income between rural and urban respondents
335 explained a large part of the differences in health outcomes between rural and urban
336 respondents. (Table 5)

337 For self-reported depression, in Model 1, rural respondents had slightly higher odds
338 ratio (OR=2.36) of reporting self-reported depression in 2011 than in 2015 (OR=2.32).
339 Adjusted for living arrangement, live near children, educational level and income
340 group, in Model 5, the odds ratio for reporting self-reported depression was 1.38 in
341 2011 and 1.66 in 2015. The difference in level of education and income between rural

342 and urban respondents explained a large part of the differences in health outcomes
343 between rural and urban respondents. (Table 6)

344 **Discussion**

345 In a representative national sample of Chinese older adults aged 60 years and above,
346 we found that rural respondents had significantly higher prevalence of poor SRH,
347 functional disabilities and self-reported depression than urban respondents, which was
348 related to their lower socioeconomic status.

349 Three health outcomes were analyzed in our study: SRH, functional abilities and
350 self-reported depression. SRH is a generic measurement of health, which is widely
351 used because of its simplicity and strong predictive power for future mortality [32, 33].
352 Poor SRH has shown to predict increased long-term mortality in healthy, middle-aged
353 individuals and in different socioeconomic groups [34]. Our results show that rural
354 respondents have worse SRH than urban respondents, which is consistent with worse
355 functional abilities, psychological health conditions and socioeconomic status. In
356 2015, the prevalence of poor SRH was lower than in 2011 among both rural and urban
357 respondents, while their educational level and income were higher.

358 Functional ability, the fundamental capability of individuals, is related to successful
359 and positive ageing [35]. Overall, difficulties in performing daily activities, both in
360 BADLs and IADLs, were strongly associated with age, and these impairments
361 appeared at younger age among rural respondents than urban respondents. There are

362 different assessments for functional ability. Most studies assessed functional abilities
363 with BADLs [36-38], measured with basic activities, such as eating and toileting.
364 BADLs have an inherent hierarchical structure intended to reflect primary biological
365 and psychosocial function [39] or, as alternately described, primary sociobiological
366 function, which is related to personal care, most often used for measuring the
367 functional ability. The measure IADLs was considered to handle that complex
368 functions normally are lost before BADLs [29], and necessary for functioning in
369 community settings. Therefore, assessing IADLs may identify incipient decline in
370 older adults or other respondents who are otherwise capable and healthy [29].
371 However, few studies include IADLs in the concept of functional disability with
372 BADLs [40-42]. Taking both of them into consideration may provide an overall
373 assessment of the functional abilities among the older adults. Our study showed that
374 the prevalence of impaired IADLs was higher than the prevalence of impaired BADLs
375 among the rural and urban older respondents in both years. The prevalence of
376 impaired BADLs among the older respondents was slightly higher in 2015 than in
377 2011. Respondents with worse health are now likely to survive longer than they
378 would have in the past, resulting in populations of older respondents with higher rates
379 of disabilities at older age.

380 Rural older adults had higher prevalence of self-reported depression than urban older
381 adults [43], the prevalence among rural respondents was nearly twice that of urban
382 respondents. The prevalence was lower in 2015 than in 2011. The improvement in

383 psychological health might be related to increasing income. It might also be related to
384 health care access, social support and participation in the society [44], however this
385 was not investigated in the present study.

386 We hypothesized that marital status would show a positive association with SRH,
387 functional abilities and self-reported depression. Many previous studies have reported
388 that married persons experience better health [45, 46]. There might be several
389 explanations for this, such as a direct health promotional effect of the marriage and
390 social support from spouse [47]. In addition, many Chinese older adults live with their
391 children and not living alone. Previous studies have concluded that living alone is an
392 independent risk factor contributing to adverse health outcomes among Chinese older
393 adults, especially among females [48, 49], and younger adults were less likely to work
394 as migrants when their parents were ill or in poor health status [50]. However, in the
395 present study, rural-urban inequalities in self-reported health outcomes were not
396 associated to living arrangements, nor to whether living near children.

397 The rural-urban inequalities in health outcomes in our study were considerable.
398 Adjusted for age and sex, we found that rural-urban inequalities in poor SRH,
399 functional disabilities, self-reported depression were to a great extent explained by
400 rural-urban inequalities in educational level and income.

401 The major strength of our study is that it is the first study that limited the samples to
402 respondents with rural Hukou living in rural areas and respondents with urban Hukou

403 living in urban areas in order to control the influence of population mobility.
404 Respondents with different Hukou are covered with different insurance and health
405 care. In CHARLS, we found that among respondents with rural Hukou, almost 25%
406 lived in urban areas, and nearly 10% of respondents with urban Hukou lived in rural
407 areas. In addition, there was a significant difference in the health outcomes between
408 the respondents who live in the same area but with different Hukou. Secondly, we
409 used a nationwide representative sample derived from the large and diverse
410 population in China to study the rural-urban inequalities in self-reported health
411 outcomes and investigate different dimensions of self-reported health status, including
412 general health, functional abilities and psychological health.

413 However, this study has several limitations. Some factors were not integrated in our
414 study due to the original focus of the study. We were not able to explore the effects of
415 other sociocultural and environmental factors due to lack of specific data. We also
416 used the individual annual income, which was calculated from household income and
417 number of household members, with nearly 60% missing data in 2015.

418 Nevertheless, our study indicates that there are important differences in self-reported
419 health, functional disabilities and self-reported depression between rural and urban
420 older adults, which to a great extent are explained by rural-urban inequalities in
421 educational level and income. Welfare state policies often aim at addressing important
422 determinants of health [51]. Our results may provide evidence for intervention

423 targeting functional abilities and may serve as a basis for interventions based on
424 individual's demographics and socioeconomic situations. Further studies should
425 investigate how health and social services might be strengthened in rural areas, in
426 order to improve health and functional abilities among rural older adults.

427 **Conclusions**

428 We found large rural-urban inequalities in poor SRH, functional disabilities and
429 self-reported depression among the older adults in China which were mainly
430 associated to rural-urban inequalities in educational level and income. Rural
431 respondents had higher prevalence of adverse health outcomes and the impairment
432 appeared at younger age among rural respondents. Our results may provide evidence
433 for interventions targeting functional abilities and may serve as a basis for
434 interventions based on individuals' demographic and socioeconomic situations.

435 **Abbreviations**

436 CHARLS: China Health and Retirement Longitudinal Study

437 SRH: Self-Rated Health

438 BADLs: Basic Activities of Daily Living

439 IADLs: Instrumental Activities of Daily Living

440 CNY: Chinese Yuan

441 OR: Odds Ratio

442 SD: Standard Deviation

443 **Declarations**

444 **Ethics approval and consent to participate**

445 All interviewees were required to sign informed consent. Ethical approval for the data
446 collection in CHARLS was granted by the Ethical Review Committee of Peking
447 University (IRB00001052–11015).

448 **Consent for publication**

449 Not applicable.

450 **Availability of data and materials**

451 The CHARLS dataset is publicly available. Information about the data source and
452 available data are found at <http://charls.pku.edu.cn/pages/data/111/en.html>.
453 Researchers can obtain these data after submitting a data use agreement to the
454 CHARLS team.

455 **Competing interests**

456 The authors declare that they have no competing interests.

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461 **Authors' contributions**

462 HJ and KB conceived the study. All authors contributed to the design. HJ carried out

463 the preliminary analyses under the supervision of KB. All authors contributed to the
464 interpretation of results. HJ drafted the first version of the work. BB, JC and KB
465 revised the manuscript critically for important intellectual content. All authors read
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Figures

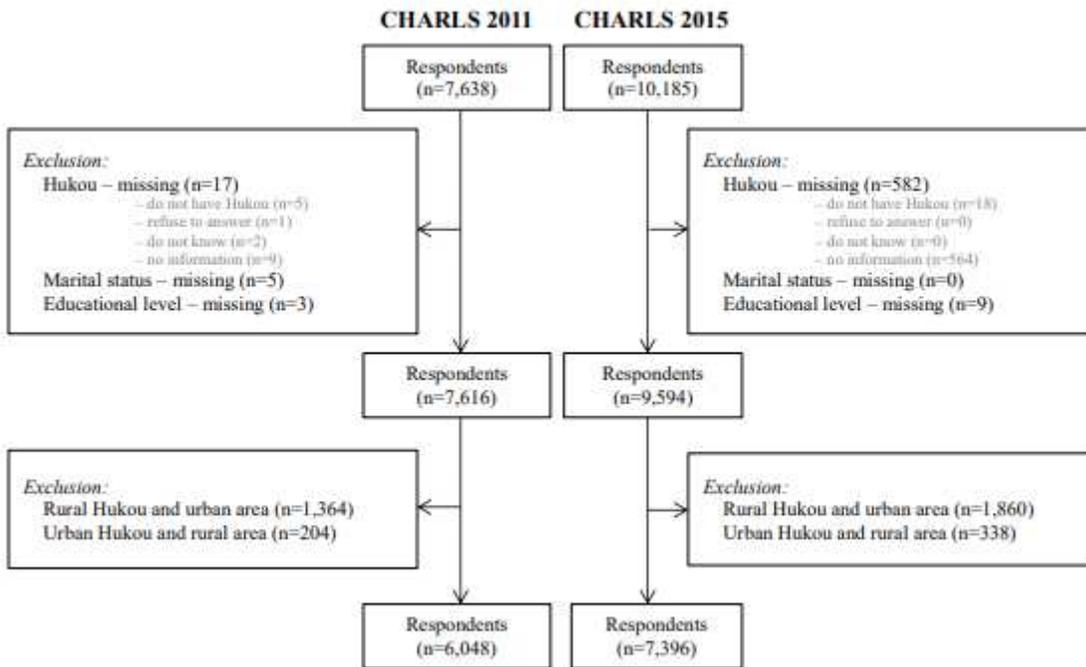


Figure 1

Flow diagram of samples, CHARLS 2011 and CHARLS 2015

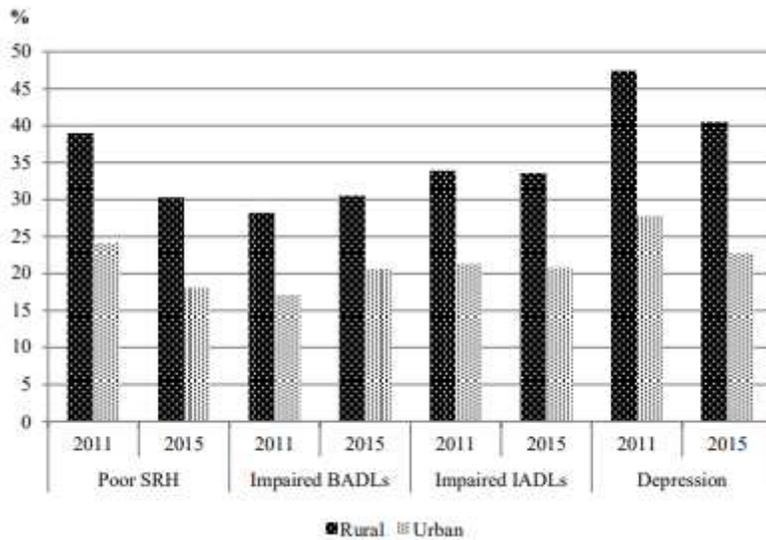


Figure 2

Prevalence (%) of poor Self-Rated Health (SRH), impaired Basic Activities of Daily Living (BADLs), impaired Instrumental Activities of Daily Living (IADLs) and self-reported depression among rural and urban respondents, CHARLS 2011 and CHARLS 2015

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