

Rural-Urban Inequalities in Poor Self-Rated Health, Self-reported 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,**
2 **self-reported functional disabilities and depression among**
3 **Chinese older adults: Evidence from the China Health and**
4 **Retirement Longitudinal Study 2011 and 2015**

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24

25 **Abstract**

26 **Background:** Rural-urban inequalities in health among older adults in China have not
27 been extensively studied from the national perspective. In particular, studies have not
28 taken into account combinations of Hukou (household registration system in China)
29 and actual residence, which may be important so as not to underestimate rural-urban
30 differences. This study investigates rural-urban inequalities in prevalence of poor
31 self-rated health, self-reported functional disabilities and depression among Chinese
32 older adults in 2011 and 2015, and analyses sociodemographic determinants of
33 rural-urban inequalities in self-reported health outcomes.

34 **Methods:** Data from the nationwide China Health and Retirement Longitudinal Study
35 (CHARLS), on older adults aged 60 years and above in CHARLS 2011 and CHARLS
36 2015 were used. Only rural residents with rural Hukou and urban residents with urban
37 Hukou were included. Sociodemographic factors, including age, sex, marital status,
38 living arrangement, living near children, educational level and income were studied.
39 Self-Rated Health (SRH) was assessed with a single question. Basic Activities of
40 Daily Living (BADLs) and Instrumental Activities of Daily Living (IADLs) were
41 used to measure self-reported functional abilities. The 10-item version of the Center
42 for Epidemiologic Studies Depression Scale was used to measure self-reported

43 depression.

44 **Results:** Rural respondents had poorer socioeconomic status and higher prevalence of
45 poor SRH, functional disabilities and depression than urban respondents. The levels
46 of functional disabilities, both BADLs and IADLs, were similar in 2011 and 2015,
47 while the prevalence of poor SRH and self-reported depression was lower in 2015,
48 both among rural and urban respondents. Impairments increased with age and
49 appeared at younger age among rural respondents compared to urban respondents.
50 Being female, unmarried, with low educational level and low income increased the
51 odds ratios of reporting poor SRH, functional disabilities and depression. Sensitivity
52 analyses using only Hukou registration resulted in underestimation of rural-urban
53 differences.

54 **Conclusions:** There were large rural-urban inequalities in poor SRH, self-reported
55 functional disabilities and depression that were closely related to rural-urban
56 differences in educational level and income.

57

58 **Key words:** China; depression; functional ability; health inequalities; household
59 registration system; older adults; rural-urban; self-rated health; social determinants of
60 health

61 **Background**

62 The proportion of older adults in China is increasing [1, 2]. By the end of 2018, there
63 were 249 million people aged 60 and over years in China, accounting for 17.9% of the
64 total population, and the population aged 65 and above reached 158 million. Life
65 expectancy of Chinese people has been continuously increasing from 35.5 years in
66 1949 to 77.0 years in 2018 [3]. This may have a major impact on the coping capacities
67 of China's health and social care systems.

68 Nearly 60% of the Chinese older adults live in rural areas [4]. Rural areas are less
69 technically and economically developed and older adults remain at home while their
70 children move to urban areas for work.[5]. Compared to older adults in urban areas,
71 those in rural areas have lower socioeconomic status [6], less access to health services
72 and social support [5] and report worse health status [7]. Disparities in living
73 conditions between rural and urban areas might influence health outcomes of older
74 adults. In addition, the household registration system (Hukou) in China, which
75 classifies each person into a rural or an urban citizen, is a major means of monitoring
76 population mobility and determining eligibility for state-provided services and
77 welfare [8]. Citizens' interests and rights, such as education, health insurance, pension
78 insurance, housing and employment, welfare and social security are determined by
79 their Hukou registration [9]. As these rights differ between rural and urban areas, it
80 may contribute to rural-urban inequalities in health outcomes [10, 11]. In addition, a
81 person with rural Hukou registration may live in an urban area and vice versa. Hence,
82 when comparing rural and urban residents, using only the Hukou registration and not
83 actual residence may cause misclassification. However, previous studies rarely take

84 population mobility into consideration.

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]. Furthermore, living alone or not [12-14] and
88 the proximity to children could influence the older adults' health [13, 15]. Studies
89 have shown that close proximity to children can be similar to co-residence [16],
90 whereas others see any kind of non-co-residence as a sign of weakened
91 inter-generational ties [17]. Socioeconomic factors may also be important
92 determinants of health disparities among rural and urban older adults [7,22,23]. Few
93 studies have compared the relationship between socioeconomic factors and
94 self-reported health outcomes in Chinese older adults and examined whether
95 rural-urban inequalities have changed over time.

96 The present study investigates rural-urban inequalities in 2011 and 2015 in the
97 prevalence of poor self-rated health, self-reported functional disabilities and
98 depression among Chinese older adults, and analyses sociodemographic determinants
99 of rural-urban inequalities in those self-reported health outcomes.

100 **Methods**

101 **Data sources**

102 The China Health and Retirement Longitudinal Study (CHARLS) is a nationally
103 representative household survey of the Chinese population [24]. It covers many
104 aspects across the interviewee's lifetime, including household information, health

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

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

119 Our study used cross-sectional data of CHARLS 2011 and CHARLS 2015 to
120 investigate the prevalence of poor self-rated health (SRH), impaired Basic Activities
121 of Daily Living (BADLs) and impaired Instrumental Activities of Daily Living
122 (IADLs) and self-reported depression among rural and urban Chinese older adults
123 aged 60 years and above. There were 7,638 respondents in CHARLS 2011 and 10,185
124 respondents in CHARLS 2015, which were included in our study.

125 **Demographic indicators**

126 In order to avoid misclassification of individuals in rural and urban areas, we

127 combined the information on Hukou registration with information on actual residence.
128 Respondents, who have rural Hukou registration (agricultural household) and live in
129 rural areas, were identified as rural respondents. Respondents, who have urban Hukou
130 registration (non-agricultural household) and live in urban areas, were considered as
131 urban respondents.

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

138 In CHARLS, respondents were asked whether they had a child who lives in the same
139 city or county. Respondents co-residing with a child, or whose child lived in the same
140 city or county were defined as “living near children”. Respondents with children not
141 co-residing nor living in the same city or county were defined as “not living near
142 children”. Respondents with no children were categorized as “no child”.

143 **Socioeconomic indicators**

144 Educational level was based on highest self-reported attained education and
145 categorized into below primary school, primary school, middle school, high school,
146 and college and above. An individual's annual income was assessed by dividing the
147 total household annual income by the number of persons living in the family within
148 the last half-year, regardless of age and employment status [25]. Total household

149 annual income is the sum of all income from all household members in the household
150 including income from earnings, capital income, pension, government transfers and
151 other income. Respondents were then ranked from lowest to highest by their annual
152 income and divided into five groups of equal size. In CHARLS 2011, the lowest
153 income group had an income below 610 Chinese Yuan (CNY); the second group from
154 611 to 2,100 CNY; the third group from 2,101 to 5,325 CNY; the fourth group from
155 5,326 to 12,067 CNY; the fifth and highest income group 12,068 CNY and above. In
156 CHARLS 2015, the lowest income group had an income below 500 CNY; the second
157 group from 501 to 1,169 CNY; the third group from 1,170 to 3,599 CNY; the fourth
158 group from 3,600 to 13,339 CNY; the fifth and highest income group 13,440 CNY
159 and above.

160 **Outcome variables**

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

162 SRH is a generic measurement of health, which is widely used because of its
163 simplicity and strong predictive power for future mortality [32, 33]. Poor SRH has
164 shown to predict increased long-term mortality in healthy, middle-aged individuals
165 and in different socioeconomic groups [34]. SRH was measured by a single question.
166 CHARLS adopted two different 5-point scales for self-reported general health, which
167 were randomly assigned to participants to examine any effects of central tendency
168 bias: i.e. that respondents either rate their health on the scale “excellent”, “very good”,
169 “good”, “fair” and “poor” or on the scale “very good”, “good”, “fair”, “poor” and
170 “very poor”. Respondents were asked about their health status twice, once in the
171 beginning of the health module with one scale and again at the end of the health

172 module with the other scale. This study focused on persons with worse health
173 outcomes, so the scale ranging from “very good” to “very poor” was used. Those who
174 answered poor or very poor health were categorized as having poor health.

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

176 Katz Activities of Daily Living Scale [26] was used to assess BADLs in CHARLS. It
177 is a 6-item scale with dressing, bathing and showering, eating, getting in and out of
178 bed, using the toilet, and controlling urination and defecation. Respondents were
179 asked “Do you have any difficulty with the following basic activity of daily living?”
180 With the scoring system used in CHARLS, each item was scored as following: 1
181 signified “do not have any difficulty”, 2 signified “have difficulties but still can do it”,
182 3 signified “have difficulties and help is needed”, and 4 signified “cannot complete it”.
183 The Chinese version of the scale has been extensively tested and has been shown to
184 yield reliable and valid responses [27]. The score of BADLs was calculated by the
185 sum of all items. Having any difficulty with an activity (total score of BADLs>6) was
186 identified as “impaired BADLs”.

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

188 IADLs are measured by the Lawton IADL Scale [28], which is ideal for
189 community-dwelling older adults, as well as those who have been admitted to a
190 hospital, short-term skilled nursing facility, or rehabilitation facility [29]. Performance
191 was examined on the 5-items scale with doing household chores, cooking, shopping,
192 managing money, taking medications [28], which are more complex levels of
193 organized human behavior than BADLs [28]. Respondents were asked “Do you have

194 any difficulty with the following instrumental activity of daily living?" With the
195 scoring system used in CHARLS, each item was scored as following: 1 signified "do
196 not have any difficulty", 2 signified "have difficulties but still can do it", 3 signified
197 "have difficulties and help is needed", and 4 signified "cannot complete it". The sum
198 score of all items >5 was categorized as "impaired IADLs".

199 **Self-reported depression**

200 In CHARLS, the 10-item version of the Center for Epidemiologic Studies Depression
201 Scale (CES-D-10) was used to measure respondents' self-reported depression.
202 CES-D-10 score is the sum of the 10 self-reported questions, after reverse coding.
203 Additionally, the scale for each of the ten questions was adjusted so that the response
204 options were 0 to 3, CES-D-10 ranges from 0 to 30 with higher scores indicating that
205 the respondent felt more negatively during the past week. Each participant was
206 categorized as having depressive symptoms if the total score of the CES-D-10 was 10
207 or above [30].

208 **Statistical analysis**

209 Respondents with missing data on Hukou registration, sex, marital status, living
210 arrangement and educational level were excluded. In an initial step, analyses were
211 performed on the prevalence rate of the health outcomes studied among respondents
212 having different Hukou registration in rural and urban areas.

213 The main analyses in this study focus on rural respondents versus urban respondents.
214 Hence, we excluded the respondents with rural Hukou registration living in urban

215 areas and respondents with urban Hukou registration living in rural areas. Therefore,
216 the final samples used for analyses were 6,048 respondents in CHARLS 2011 and
217 7,396 respondents in CHARLS 2015 (Figure 1).

218 Descriptive statistics were presented as means with standard deviation (SD) for
219 numerical variables, or as percentages for categorical variables.

220 Differences in the prevalence of poor SRH, impaired BADLs, impaired IADLs and
221 self-reported depression between the rural and urban respondents were examined
222 separately for 2011 and 2015, by using Chi-square test or Fisher's Exact test for
223 nominal categorical variables [31] and for variables with ordinal explanatory variables.
224 Independent T-test was used to analyze the differences between rural and urban
225 respondents in means of age and income. Multiple logistic regression models were
226 performed to examine the over-risk of poor SRH, functional disabilities and
227 depression among rural respondents and to what extent this over-risk was explained
228 by sociodemographic determinants, adjusting for age and sex.

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

232 **Results**

233 **Results of initial analyses on Hukou registration and residence**

234 Based on the initial analyses, the distribution of all respondents with different Hukou

235 registration in rural and urban areas is shown in Supplementary Table S1. In 2011,
236 24% of those with rural Hukou registration lived in urban areas, and 11% of those
237 with urban Hukou registration lived in rural areas. In 2015, these proportions were
238 26% and 14%, respectively (Supplementary Table S1). Hence, in view of our
239 objective to identify rural residents (with rural Hukou registration, living in rural areas)
240 and urban residents (with urban Hukou registration, living in urban areas), some 35 to
241 40% of respondents were misclassified, if only Hukou registration had been used.

242 **Individual characteristics**

243 In the main analysis sample used in this study, the proportion of rural respondents was
244 similar, nearly 73%, in 2011 and 2015. Rural respondents were slightly younger than
245 urban respondents. There were more females among rural respondents than urban
246 respondents in 2015 (Table 1).

247 Compared to urban respondents, more rural respondents were unmarried. In 2011,
248 nearly 10% of rural respondents and nearly 14% of urban respondents lived alone
249 (compared to 9% rural respondents and 8% urban respondents in 2015). Fewer
250 respondents lived near their children in 2015 than in 2011 (Table 1).

251 Rural respondents had lower levels of education and income than urban respondents.
252 In 2011 67% of the rural respondents had less than primary school, compared to 27%
253 of urban respondents. In 2015, this proportion was slightly lower, among both rural
254 and urban respondents. The mean individual annual income was about four times
255 higher among urban respondents than among rural respondents, (Table 1).

256 **Prevalence of health outcomes in 2011 and 2015**

257 Figure 2 shows the prevalence of all four health outcomes among rural and urban
258 respondents, respectively, in 2011 and 2015. Rural respondents reported worse health
259 outcomes than urban respondents. The prevalence of poor SRH and self-reported
260 depression was statistically significantly lower in 2015 than in 2011, while the
261 prevalence of impaired BADLs was significantly higher among both rural and urban
262 respondents in 2015 than in 2011. There was no difference in the prevalence of
263 impaired IADLs between the years among rural respondents, or among urban
264 respondents.

265 Supplementary Table S2 also includes the results of the initial analyses of the
266 prevalence rate of the health outcomes studied among respondents excluded from the
267 main analyses, having discordant Hukou registration in rural and urban areas. The
268 prevalence varied considerably between the different combinations of Hukou
269 registration and actual residence. Respondents with rural Hukou registration who
270 lived in urban areas had lower prevalence rate of the health outcomes than those
271 living in rural areas. Respondents with urban Hukou registration living in rural areas
272 had higher prevalence rate of the health outcomes than those living in urban areas,
273 except impaired IADLs in 2011.

274 **Prevalence of poor SRH by individual characteristics**

275 Rural respondents reported higher prevalence of poor SRH than urban respondents
276 (Table 2). The prevalence of poor SRH in 2015 was lower than in 2011, significantly
277 declining from 39 % to 30% among rural respondents and from 24% to 18% among

278 urban respondents (Figure 2 and Table 2).

279 Rural respondents had significantly higher prevalence of poor SRH than urban
280 respondents within each age group (Table 2). The youngest age group (60–64 years)
281 of rural respondents had higher prevalence of poor SRH (36%) than urban
282 respondents aged 85–89 years (30%). The prevalence of poor SRH increased with age,
283 except among respondents aged 90+ years.

284 More females than males reported poor SRH, especially among rural respondents.

285 Unmarried respondents had higher prevalence of poor SRH than married respondents.

286 There was a gradient in poor SRH by education and income, with higher prevalence
287 of poor SRH among respondents with lower educational level and lower income, both
288 among rural and urban respondents (Table 2).

289 **Prevalence of impaired BADLs by individual characteristics**

290 The prevalence of impaired BADLs among the older respondents was slightly higher
291 in 2015 than in 2011 (Supplementary Table S3). The prevalence of impaired BADLs
292 increased with age. Compared to urban respondents, the impairments of BADLs
293 appeared at younger age among rural respondents. In 2011, rural respondents aged
294 60–64 had higher prevalence of impaired BADL than urban respondents aged 75–79
295 years. There was no significant difference in the prevalence of impaired BADLs
296 between rural and urban respondents who were aged 80 years and above. The
297 prevalence of impaired BADLs was higher among females and respondents living
298 alone than among males and respondents not living alone. In 2011, the prevalence of
299 impaired BADLs among rural respondents who did not live near children was 32%,

300 compared to nearly 7% among urban respondents who did not live near children.
301 However, in 2015, the prevalence of impaired BADLs among rural respondents was
302 26%, while nearly 15% of urban respondents who did not live near children reported
303 impaired BADLs.

304 The prevalence of impaired BADLs was lower among groups with higher educational
305 level and higher income level. There was no significant difference in the prevalence
306 of impaired BADLs between rural and urban respondents within each income group,
307 except in the lowest income group in 2015 and the highest income group in both years
308 (Supplementary Table S3).

309 **Prevalence of impaired IADLs by individual characteristics**

310 The prevalence of impaired IADLs among the older respondents was similar in 2011
311 and 2015 (Supplementary Table S4). The prevalence of impaired IADLs increased
312 with age. Compared to urban respondents, the impairments of IADLs among rural
313 respondents appeared at younger age. In 2015, rural respondents aged 65–69 years
314 had higher prevalence (31%) of impaired IADL than urban respondents aged 75–79
315 years (29%). There was no significant difference in the prevalence of impaired BADLs
316 between rural and urban respondents who were aged 85 years and above in 2011 or
317 2015. The prevalence of impaired IADLs was higher among females than males.
318 There was no significant difference between respondents living alone and not living
319 alone. Compared to respondents who did not live near children, those living near
320 children had higher prevalence of impaired IADLs. The respondents with no children
321 reported higher prevalence of impaired IADLs.

322 Groups with higher educational level and higher income level had a lower prevalence
323 of impaired IADLs. There was no significant difference in the prevalence of impaired
324 IADLs between rural and urban respondents within each income group, except in the
325 lowest income group in 2015 and the highest income group in both years
326 (Supplementary Table S4).

327 **Prevalence of self-reported depression by individual characteristics**

328 Compared to urban respondents, nearly twice as many rural respondents reported
329 self-reported depression (Supplementary Table S5). The prevalence of self-reported
330 depression among respondents was lower in 2015 than in 2011. The prevalence of
331 self-reported depression was 47% in 2011 and 41% in 2015 among rural respondents,
332 compared to 28% in 2011 and 23% in 2015 among urban respondents.

333 There was a significant difference of reporting depression between rural and urban
334 respondents within each age group. Older respondents generally had higher
335 prevalence of depression, but the prevalence was high also in the youngest age group
336 of rural respondents. Respondents living alone, being unmarried, with lower
337 educational level and lower income had a higher risk of reporting depression. More
338 female than males reported depression, especially among rural respondents
339 (Supplementary Table S5).

340 **Sociodemographic determinants of poor SRH, self-reported 341 functional disabilities and depression**

342 Multiple logistic regression analyses were done to estimate to what extent differences

343 in sociodemographic determinants could explain rural-urban differences in health
344 outcomes. After adjusting for age and sex, the difference in level of education and
345 income between rural and urban respondents explained a large part of the differences
346 in health outcomes between rural and urban respondents. Living alone or living near
347 children was not significantly related to health outcomes.

348 As shown in Table 3a (2011) and 3b (2015), in Model 1, after adjusting for age and
349 sex, rural respondents had a higher odds ratio of reporting poor SRH in 2011
350 (OR=2.05) and in 2015 (OR=2.00). Further adjustment for marital status, living
351 arrangement, living near children (Model 2) did not significantly change the odds
352 ratio for rural respondents. In Model 3, further adjustment for education level reduced
353 the odds ratio for having poor SRH among rural respondents in 2011 (OR=1.66) and
354 in 2015 (OR=1.74).. In 2011, when instead adjusting for income group (Model 4) the
355 odds ratio was lower (OR=1.55) (Table 3a). In the full model for 2011 (Model 5), the
356 odds ratio for having poor SRH was further reduced (OR=1.34). In 2015, the
357 proportion of respondents with missing information of income was more than 50%;
358 hence income was not included in the regression analysis.

359 Similar findings were seen in regression analyses for impaired BADL, impaired IADL
360 and self-reported depression (Supplementary Tables S6, S7 and S8, respectively). For
361 impaired BADLs, in Model 1, rural respondents had higher odds ratio of having
362 impaired BADLs in 2011(OR=1.99) than in 2015 (OR=1.76). In 2011, adjusting for
363 living arrangement, live near children, educational level and income group, in Model
364 5, reduced the odds ratio for having impaired BADLs to 1.09 (Table S6).

365 For impaired IADLs, in Model 1, the odds ratio of rural respondents reporting

366 impaired IADLs was 2.05 in 2011 and 2.03 in 2015. In 2011, adjusting for living
367 arrangement, live near children, educational level and income group, in Model 5,
368 reduced the odds ratio for reporting impaired IADLs to 1.13 (Table S7).

369 For self-reported depression, in Model 1, rural respondents had higher odds ratio
370 (OR=2.36) of reporting self-reported depression in 2011 and in 2015 (OR=2.32). In
371 2011, adjusting for living arrangement, live near children, educational level and
372 income group, in Model 5, reduced the odds ratio for having self-reported depression
373 to 1.38 (Table S8).

374 **Discussion**

375 This study found substantially higher rates of adverse health outcomes among rural
376 than urban respondents, both in 2011 and 2015. The prevalence rate of poor SRH,
377 impaired IADLs and self-reported depression was lower in 2015 than in 2011, but the
378 prevalence rate of impaired BADLs was higher in 2015 than in 2011. However, the
379 rural-urban differences were similar in both years. A novel classification, combining
380 Hukou registration with actual residence, was used to distinguish rural respondents
381 from urban respondents. The usual classification, using only Hukou registration and
382 not actual residence, resulted in smaller rural-urban differences.

383 Rural respondents with lower socioeconomic status had statistically significantly
384 higher prevalence of poor SRH, self-reported impaired BADL and IADL, and
385 self-reported depression than urban respondents, which is in line with other studies [7,

386 22, 25]. It is also consistent with lower life expectancy in rural compared to urban
387 areas [35]. In 2010, the life expectancy in Beijing and Shanghai was 80.2 years,
388 compared to 72.2 years in Gansu province [36].

389 Our results show that rural respondents have worse SRH than urban respondents,
390 which is consistent with worse functional abilities, psychological health conditions
391 and socioeconomic status.

392 Functional ability, the fundamental capability of individuals, is related to successful
393 and positive ageing [37]. Overall, difficulties in performing daily activities, both in
394 BADLs and IADLs, were strongly associated with age, and these impairments
395 appeared at substantially younger age among rural respondents than urban
396 respondents. This may indicate that the need of assistance because of functional
397 limitations begins at an earlier age among rural residents.

398 There are different assessments for functional ability. Our study showed that the
399 prevalence of impaired IADLs was higher than the prevalence of impaired BADLs
400 among the rural respondents in both years, and slightly higher in 2015 than in 2011.
401 Most studies assess functional abilities with BADLs [38–40], measured with basic
402 activities, such as eating and toileting. BADLs have an inherent hierarchical structure
403 intended to reflect primary biological and psychosocial function [41] or, as alternately
404 described, primary sociobiological function, which is related to personal care, most

405 often used for measuring the functional ability. The measure IADLs is considered to
406 handle that complex functions normally are lost before BADLs [29], and necessary
407 for functioning in community settings. Therefore, assessing IADLs may identify
408 incipient decline in older adults or other respondents who are otherwise capable and
409 healthy [29]. However, few studies include IADLs in the concept of functional
410 disability with BADLs [42–44]. Taking both into consideration may provide an
411 overall assessment of the functional abilities among the older adults. Respondents
412 with worse health are now likely to survive longer than they would have in the past,
413 resulting in populations of older respondents with higher rates of disabilities at older
414 age.

415 In our study, rural older adults had nearly two times higher prevalence of self-reported
416 depression than urban older adults, which is similar to other studies [45], The
417 prevalence was lower in 2015 than in 2011. The improvement in psychological health
418 might be related to increasing income. It might also be related to improved health care
419 access, social support and participation in the society [46], however this was not
420 investigated in the present study.

421 We hypothesized that marital status would show a positive association with SRH,
422 functional abilities and self-reported depression. This was also seen in our study, as in
423 other studies [47, 48]. There might be several explanations for this, such as a direct
424 health promotional effect of the marriage and social support from spouse [49]. In

425 addition, many Chinese older adults live with their children and not alone. Previous
426 studies have concluded that living alone is an independent risk factor contributing to
427 adverse health outcomes among Chinese older adults, especially among females [50,
428 51], and that younger adults were less likely to work as migrants when their parents
429 were ill or in poor health status [52]. However, in the present study, rural-urban
430 inequalities in self-reported health outcomes were not associated to living
431 arrangements, nor to whether living near children.

432 The main focus of our study was on rural-urban inequalities in health outcomes.
433 These health inequalities were considerable, with two-fold odds ratios of poor SRH,
434 impaired BADL, impaired IADL and depression among rural compared to urban
435 residents. The health inequalities reflect and are closely related to large differences in
436 the level of education and income between rural and urban areas. Urban respondents
437 had four times higher income than rural residents, and two-thirds of rural respondents
438 had below primary school, compared to one-fourth in urban areas. The rural-urban
439 inequalities in poor SRH, functional disabilities and self-reported depression were to a
440 large extent explained by rural-urban inequalities in educational level and income. In
441 2011, especially the rural/ urban differences in income explained a large part of the
442 rural-urban differences in health outcomes. Due to the large number with missing data
443 on income in 2015, the role of income could not be studied.

444 **Strengths and limitations**

445 A major strength of our study is that it is the first study that limited the samples to
446 respondents with rural Hukou living in rural areas and respondents with urban Hukou
447 living in urban areas in order to control the influence of population mobility.

448 Respondents with different Hukou are covered by different insurance and health care.

449 In CHARLS, we found that among respondents with rural Hukou, almost 25% lived
450 in urban areas, and more than 10% of respondents with urban Hukou lived in rural
451 areas. In addition, there was a significant difference in the health outcomes between
452 the respondents who lived in the same area but with different Hukou. This underlines
453 the importance of taking not only Hukou registration but also actual residence into
454 account, when comparing rural and urban residents. Using only Hukou registration
455 underestimated the differences between rural and urban respondents.

456 Another strength is that we used a nationwide representative sample derived from the
457 large and diverse population in China to study the rural-urban inequalities in
458 self-reported health outcomes and investigate different dimensions of self-reported
459 health status, including general health, functional abilities and psychological health.

460 However, this study also has several limitations. Some factors were not included in
461 our study. We were not able to explore the effects of other sociocultural and
462 environmental factors due to lack of specific data. Unfortunately, the importance of
463 level of income could not be studied in 2015 because of the large proportion (nearly
464 60%) with missing data on income in 2015. In addition, this study shows only a four

465 year difference, which might be not long enough time to show a trend, but it might
466 also contribute to the sparse literature on whether rural-urban inequalities have
467 changed over the years. The cross-sectional design of the study prevents causal
468 inference.

469 Nevertheless, our study indicates that there are important differences in self-reported
470 health, functional disabilities and self-reported depression between rural and urban
471 older adults, which to a great extent were explained by rural-urban inequalities in
472 educational level and income, which are central determinants of health. Redistribution
473 of income from rich to poor may be one of the most important policy levers for
474 improving population health [36]. Welfare state policies and interventions often aim at
475 addressing important determinants of health [53]. Our results may provide a basis for
476 interventions to improve health and functional abilities among older people,
477 addressing differences in demographics and socioeconomic conditions between rural
478 and urban areas. Further studies should investigate how health and social services
479 might be strengthened in rural areas, in order to improve health and functional
480 abilities among rural older adults.

481 **Conclusions**

482 Using a novel classification, combining Hukou registration and actual residence, to
483 distinguish rural and urban residents, we found large rural-urban inequalities in poor

484 SRH, functional disabilities and self-reported depression among older adults in China
485 which were to a great extent associated to rural-urban inequalities in educational level
486 and income. Rural respondents had higher prevalence of adverse health outcomes and
487 the impairment appeared at younger age among rural than urban respondents. Our
488 results may provide a basis for interventions to improve health and functional abilities
489 among older people, addressing differences in demographic and socioeconomic
490 conditions and access to health and social services between rural and urban areas.

491 **Abbreviations**

492 CHARLS: China Health and Retirement Longitudinal Study

493 SRH: Self-Rated Health

494 BADLs: Basic Activities of Daily Living

495 IADLs: Instrumental Activities of Daily Living

496 CNY: Chinese Yuan

497 OR: Odds Ratio

498 SD: Standard Deviation

499 **Declarations**

500 **Ethics approval and consent to participate**

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

504 **Consent for publication**

505 Not applicable.

506 **Availability of data and materials**

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

511 **Competing interests**

512 The authors declare that they have no competing interests.

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517 **Authors' contributions**

518 HJ and KB conceived the study. All authors contributed to the design. HJ carried out
519 the preliminary analyses under the supervision of KB. All authors contributed to the
520 interpretation of results. HJ drafted the first version of the work. BB, JC and KB
521 revised the manuscript critically for important intellectual content. All authors read
522 and approved the final manuscript submitted for publication.

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Figures

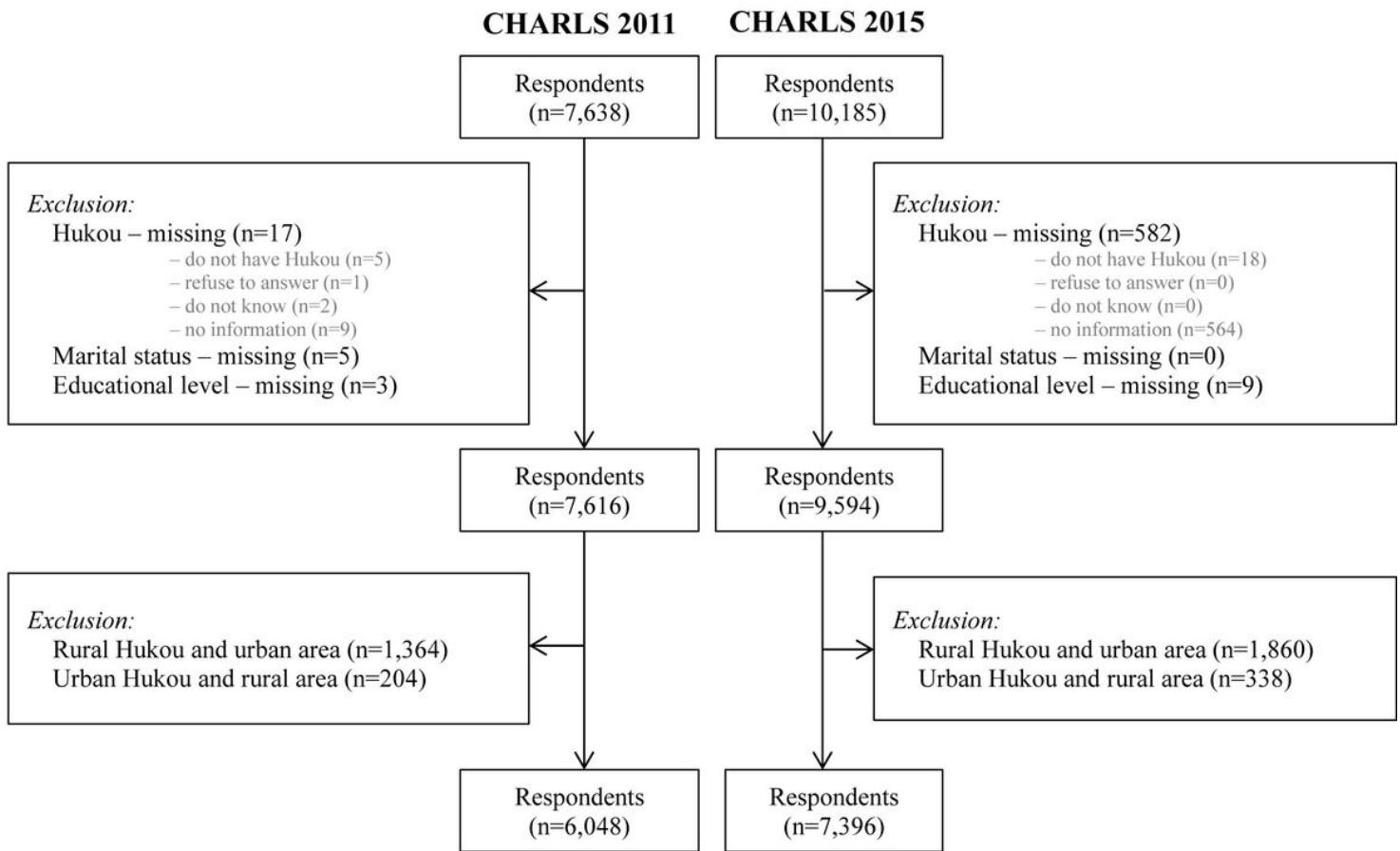


Figure 1

Flow diagram of samples, CHARLS 2011 and CHARLS 2015

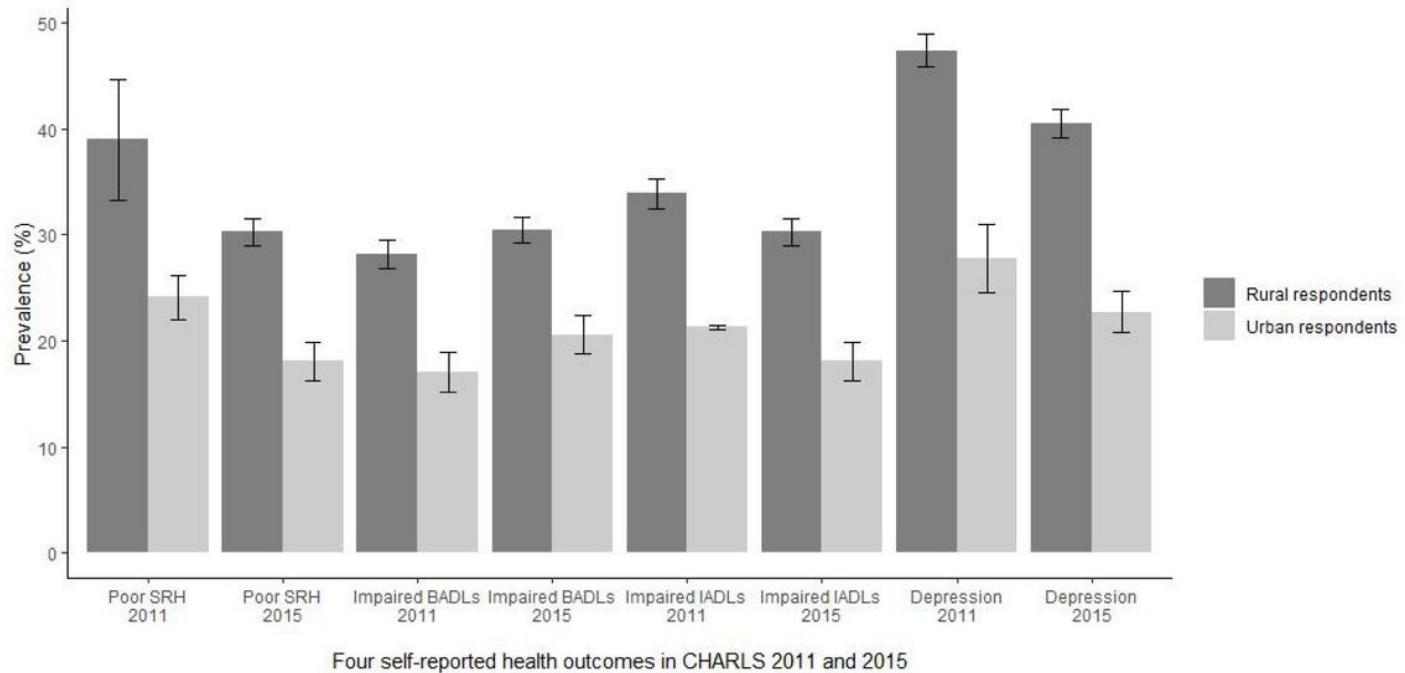


Figure 2

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

Supplementary Files

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