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1 **Implication of the WHO growth standards on estimation of**
2 **malnutrition in young Chinese children: Two examples from rural**
3 **western China and Tibet region**
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34 **Implication of WHO growth standards on estimation of malnutrition in**
35 **young Chinese children: Two examples from rural western China and**
36 **the Tibet region**

37
38
39 **Abstract**

40
41 The aim of this study was to determine how malnutrition rates change in young Chinese
42 children when 2006 WHO growth standards are used instead of 1978 WHO/NCHS
43 reference. Cross-sectional survey data were used from rural western China and the Tibet
44 region. The heights and weights of children <36 months of age were measured. The
45 nutritional status of the children was assessed by two references. Using 2006 reference
46 instead of 1978 reference, the prevalence of stunting increased significantly (17.9%
47 vs.12.3% in rural western China and 37.5% vs. 28.1% in rural Tibet). The prevalence of
48 underweight was lower in rural western China (7.7% vs.11.7%) than rural Tibet (13.1%
49 vs.15.3%). For all ages, the prevalence of stunting increased and the greatest relative
50 increase appeared in the first 6 months (102.9% in rural western China vs. 134.9% in
51 rural Tibet). With respect to underweight, the relative increase only occurred during the
52 first 6 months (314.3% in rural western China vs. 48.1% in rural Tibet); however, the
53 reduction was observed in other age groups. For young Chinese Han and Tibetan children,
54 the difference in estimation of malnutrition between two references differed in magnitude.
55 The scale of change in the prevalence rates of stunting and underweight is much greater
56 when 2006 reference was introduced.

60 **Introduction**

61 Height and weight are important indicators reflecting child growth or nutritional status,
62 and are also commonly used to predict performance, health, and survival. A child growth
63 reference, based on data of a well-nourished child population, is required for assessment
64 of nutritional status of children (WHO 1995; WHO Working Group on the Growth
65 Reference Protocol, Task Force on Methods for the Natural Regulation of Fertility 2000).
66 The original National Center for Health Statistics (NCHS) growth curves were
67 formulated in 1975 and adopted by WHO as the international reference in 1978 (Hamill
68 *et al.* 1979) (*referred to as 1978 reference hereafter*). A revision was carried out by CDC
69 in 1990 to correct some of the irregularities (WHO Working Group on Infant Growth
70 1995; de Onis & Yip 1996; Dibley *et al.* 1987; Yip, Scanlon & Torwbridge 1993). In
71 2006, WHO generated new growth standards through the Multicentre Growth Reference
72 Study (MGRS) (de Onis *et al.* 2004; WHO Multicentre Growth Reference Study Group
73 2006). The standards were developed with a pooled sample of approximately 8,500
74 children from six countries (Brazil, Ghana, India, Oman, Norway, and United States)
75 (*referred to as 2006 reference hereafter*).

76 The NCHS reference has been adopted by many national programs for growth
77 monitoring or nutrition intervention and has allowed international comparisons (de Onis,
78 Wijnhoven & Onyango 2004). Introduction of a new growth reference may interfere with
79 the comparisons; consequently a striking misclassification of the nutritional status of
80 children might affect adoption of a new reference. To date, some studies have shown
81 inconsistent results when using the two references in some child populations. Onyango *et al.*
82 *al.* (2007) reported good agreement between the two references. de Onis *et al.* (2006;

83 2007) suggested that a significant difference existed in the estimation of the prevalence of
84 malnutrition derived from different references, but new standards provided a better tool
85 for monitoring the rapid and changing rate of growth in early infancy. Two studies found
86 that the 2006 reference resulted in a higher prevalence of acute malnutrition which could
87 affect nutritional programs (Prost *et al.* 2008; Seal & Kerac 2007) but another study
88 indicated reduction of prevalence of wasting (Orellana *et al.* 2009). Studies from the
89 United Kingdom and Hong Kong suggested that new standards would not be suitable for
90 all child populations, especially for East-Asian children (Wright *et al.* 2008; Hui *et al.*
91 2008). Therefore, further assessment on the difference between the two references is
92 required in different child populations. However, few comparisons between the two
93 references have been conducted among young Chinese children. To make use of new
94 standards more rationally, we investigated how malnutrition rates change in young
95 Chinese children when the 2006 reference was used instead of the 1978 reference. In the
96 current study, two child samples with different environmental and cultural backgrounds,
97 one from rural western China and the other from rural Tibet, were used for investigating
98 such changes.

99

100 **Methods**

101 **Study setting and the samples**

102 Western China consists of 12 provinces including the Tibet region. The area in western
103 China accounts for 71.6% of China's land area, and > 70% of people live in rural areas.
104 The Tibet region is located on the Qinghai-Tibet plateau, where 86% of the areas is at an
105 altitude > 4000 m; the area is hypoxic and the climate is cold. The rural population

106 account for 87% of the total population and > 95% of people belong to the Tibetan ethnic
107 group (National Bureau of Statistics of China 2004; Liu 1988). Hence, Tibetan children
108 live in a different environment compared with their Chinese Han counterparts living in
109 other areas of western China. In the current study we present the results of rural Tibetan
110 children and children from rural western China (not including rural Tibet) separately.

111 Data from two surveys were used in our analysis, which were conducted in rural
112 western China and the rural Tibet region in 2005. The purpose of both surveys involved
113 maternal and child healthcare and children < 36 months of age were investigated. The
114 same stratified multistage random sampling method was adopted. In the sample from the
115 rural western China survey, most of the children were of the Chinese Han ethnic group.
116 The survey covered 45 counties, which were selected in terms of social and economic
117 development. Sixteen households with children <36 months of age were selected
118 randomly in each sample village of the sampled township. A sample of 14,000 children
119 was estimated to detect a 20% malnutrition rate and 30% acceptable variability in each
120 specific gender-age group, assuming $\alpha=0.05$ and $1-\beta =90\%$ and accounting for an
121 expected 20% non-response rate.

122 In the sample from the rural Tibet survey, all children belonged to the Tibetan ethnic
123 group. Fifteen counties were selected from four districts of Tibet, which were located at
124 elevations from 3,000-5,000 m. Due to the small size of these counties, there were five
125 townships randomly selected instead of villages in each county. Sixteen households with
126 children < 36 months of age were selected randomly from each selected township. The
127 sample size of 1300 was estimated assuming a malnutrition rate of 20%, an error of 10%,
128 $\alpha=0.05$, and $1-\beta = 90\%$ and accounting for an expected 20% non-response rate.

129

130 **Anthropometry and definition of malnutrition**

131 Anthropometric measurements were obtained from the investigated children using
132 standard measurement techniques. Body weight without shoes, but while wearing
133 underwear, was measured using an electronic scale (Tanita HD-305, Tanita Corporation,
134 Shanghai, China) with precision to the nearest 100 g. Body length without shoes was
135 measured to the nearest millimeter using a portable measuring board with a fixed head
136 piece (Model WB-II, Xi'an Teaching Instrument Company, Xi'an, China). Weight-for-age
137 Z scores (WAZ), height-for-age Z scores (HAZ) and weight-for-height Z scores (WHZ)
138 were derived from the observational data based on the 1978 and 2006 references.
139 Underweight, stunting, and wasting were defined as WAZ, HAZ, and WHZ less than - 2,
140 respectively (WHO 1995).

141 A face-to-face interview was conducted in households using a household questionnaire
142 and anthropometric tools. Verbal informed consent was obtained from all of the children's
143 mothers. The accurate age of each child was collected from the permanent residence
144 registration and/or immunization records. When necessary, Chinese Han or Tibetan lunar
145 calendar dates were converted to Gregorian calendar dates. The anthropometric
146 measurements were collected by trained staff. This study was approved by the Ethical
147 Committee of Xi'an Jiaotong University (China).

148

149 **Data analysis**

150 A database was established by duplicate entries using EpiData 3.02. Prior to data analysis,
151 data cleaning and quality check were performed. Software of WHO Anthro (version 3.2.2;

152 WHO) was used for calculation of Z scores based on the 1978 and 2006 references. A
153 flexible exclusion range was used to exclude the unreasonable anthropometric data
154 (WHO 1995). The data analysis was adjusted for the stratified multistage cluster random
155 sampling used in the surveys to ensure an appropriate width of the confidence intervals.
156 In the adjustments, the county was regarded as a strata variable. The village for the
157 western China survey was used as a cluster variable, while the township as a cluster
158 variable for the Tibet survey. Weights were obtained based on the proportion of
159 investigated households in the counties to overall households of the counties. Then, the
160 weighted prevalence of malnutrition with 95% confidence intervals (CI) was calculated.
161 McNemar test was used for comparison of prevalence rates from the two references.
162 Distributions of Z scores from the two references were made for the description of the
163 overall nutritional status. Comparison of Z-score means from the two references in the
164 two surveys was carried out using a mixed model. In this model, gender, age, economic
165 status, mother's education and altitudes were treated as co-variables, and survey,
166 reference, and interaction between survey and reference were treated as fixed effects,
167 whereas the subject was treated as a random effect. The estimated Z-score mean
168 differences between the two references in the two surveys from the model were reported
169 together with 95% CI. A two-sided P-value < 0.05 was considered statistically significant.
170 Stata/SE (version 9.0; StataCorp) was used for all analyses.

171

172 **Results**

173 *Characteristics of the two samples*

174 For the sample from rural western China, anthropometric data was obtained from 13,371

175 children. Approximately 4.4% of data had flagged errors and excluded from the analyses.
176 Data available for this study were 12,783 children and the weighted counts were 12,222.
177 Among the children, 58% were boys and 96% were breast-fed. Of the children's families,
178 85% earned a living mainly by farming. Of the children's mothers, 61% had 6-9 years of
179 schooling. For the sample from rural Tibetan, anthropometric data was gathered from
180 1455 children. Approximately 6.7% of the data had flagged errors and excluded from the
181 analyses. Data available for this study were 1357 children and the weighted counts were
182 1344. Among them, 56% were boys and 61% had exclusive breastfeeding within 4
183 months after birth. Greater than one-half (54%) of the children's families earned a living
184 by farming. Of the children's mothers, 58% had no schooling and only 14% had > 6 years
185 of schooling. All Tibetan children surveyed lived at an altitude > 3,500 m.

186

187 *Distributions of Z scores based on the two references*

188 The distribution of Z scores was shifted to the left compared with the reference
189 distribution, especially for the HAZ and WAZ, irrespective of which reference was used.
190 However, the magnitude of the shift varied depending on the reference used, indicators,
191 and child population. In rural western China, the distribution of the HAZ from the 2006
192 reference was shifted downward much more than the 1978 reference. The mean HAZ was
193 -0.83 from the 2006 reference, which was significantly lower than -0.65 from the 1978
194 reference. The reverse situation existed for the WAZ. The mean WAZ was -0.49 from the
195 2006 reference significantly higher than -0.66 from the 1978 reference. With respect to
196 WHZ, the magnitude of the shift was greater than for that of the HAZ and WAZ when
197 using the 2006 reference (Figure 1 and Table 1).

198 In rural Tibet, the same shifting trend was observed as in rural western China. However,
199 when the 2006 reference was used, the HAZ shifted more than the WAZ, but in an
200 inverse direction. In comparison of rural Tibet with rural western China, the mean
201 difference between the two references was statistically significant in the HAZ (-0.226 vs.
202 -0.186) and the WAZ (0.145 vs. 0.158) ($P < 0.05$) but similar to the WHZ (0.226 vs. 0.229;
203 $P > 0.05$) after controlling for potential factors (Figure 1 and Table 1).

204

205 *General prevalence of malnutrition based on the two references*

206 In rural western China, the prevalence of stunting increased from 12.3% using the 1978
207 reference to 17.9% using the 2006 reference, or a relative increase of 45.5%. The
208 prevalence of underweight based on the 2006 reference was lower than the 1978
209 reference (7.7% vs. 11.7%). For the prevalence of wasting, a relative reduction of 14.8%
210 was observed (Table 1).

211 In rural Tibet, the prevalence of stunting using the 2006 reference was higher
212 compared with the 1978 reference and the relative increase was 33.5%, which was lower
213 than rural western China. The prevalence of underweight decreased from 15.3% using the
214 2006 reference to 13.1% using the 1978 reference, or a relative reduction of 14.4%,
215 which was less than rural western China. The prevalence of wasting was 3.4% for the
216 1978 reference and 2.6% for the 2006 reference. The relative reduction was 23.5% (Table
217 1).

218

219 *Prevalence of malnutrition by age based on the two references*

220 Table 2 shows the prevalence and variation by age derived from the two references. In

221 rural western China, the prevalence of stunting from the 2006 reference was higher than
222 the 1978 reference for all age groups. During the first 6 months, greatest relative increase
223 in stunting occurred (102.9%), i.e., the prevalence assessed by the 2006 reference was
224 about 1-fold greater than that derived from the 1978 reference. Another significant
225 relative increase occurred after 24 months, ranging from 80.1-85%. With respect to
226 underweight, during the first 6 months the prevalence derived from the 2006 reference
227 was 3.14-fold greater than that from the 1978 reference. The prevalence rates derived from the
228 2006 reference during the 2nd year after birth were reduced and relative reduction was
229 between 47.4% and 43.1%. The variation for wasting by age was similar to the
230 underweight. During the first 6 months the prevalence derived from the 2006 reference
231 was 1.81-fold greater than that from the 1978 reference. Thereafter, the prevalence rates
232 derived from the 2006 reference were lower than or similar to that derived from 1978
233 reference.

234 In rural Tibet, compared with the 1978 reference, the greatest increase (134.9%) for
235 stunting occurred during the first 6 months when using the 2006 reference, which was
236 slightly higher compared with rural western China. The prevalence of stunting was
237 reduced in other age groups, but the magnitude of the reduction was less than rural
238 western China. With respect to underweight, a relative increase of 48.1% during the first
239 6 months was observed, which was much lower than rural western China. From 6-30
240 months, the prevalence rates of underweight derived from the 2006 reference were
241 reduced compared with the 1978 reference but the relative reductions were lower than
242 western China. After 30 months there was a slight increase in the prevalence of
243 underweight when using the 2006 reference. The variation in the prevalence of wasting

244 assessed by the two references was similar to western China, except for the reduced
245 prevalence of wasting during the first 6 months when using the 2006 reference.

246 Our sample might present specific changes in malnutrition rates using the 2006
247 reference instead of the 1978 reference. Compared with Bangladeshi children, our sample
248 children had a higher increase in prevalence rates of stunting for each age group,
249 especially during the first 6 months (102.9% in rural western China vs. 134.9% in rural
250 Tibet vs. 56% in Bangladesh). The prevalence of wasting was complex, and different
251 variations in the prevalence of wasting by age were observed in the three child
252 populations (Table 2).

253

254 **Discussion**

255 In this study, we used two larger samples, one with a lower prevalence of malnutrition
256 and the other with a relatively higher prevalence, to explore the impact of new WHO
257 growth standards on the assessment of the nutritional status of young Chinese children.
258 Both child populations were quite different based on culture and natural environment
259 where they lived, and they might have specific growth patterns (Liu 1988; Harris *et al.*
260 2001; Dang, Yan & Yamamoto 2008). As expected, there was an important difference
261 found between the 1978 and 2006 references in assessing the nutritional status of younger
262 Chinese children. This difference varied by index population, growth indicator, and age
263 group.

264 The current study showed that rural Chinese children tended to be smaller in height-
265 for-age but greater in weight-for-age or weight-for-height when the 2006 reference was
266 used. Stunting became an outstanding malnutrition of rural children in western China,

267 which was consistent with other Chinese studies (Chen *et al.* 2011; Mak & Tan 2012).
268 The prevalence of stunting and underweight was higher in our samples compared with
269 overall rural China (16.3% for stunting and 6.1% for underweight). Specifically rural
270 Tibetan children had a much higher prevalence of stunting because higher altitude may
271 account for the reduction of height of Tibetan children (Dang, Yan & Yamamoto 2008).
272 Childhood malnutrition may yield adverse outcomes in the adolescence. About 6-10% of
273 Chinese adolescents remained underweight (Zhang & Wang 2011), which may partly due
274 to maintenance of childhood underweight because 33% of underweight children in
275 childhood were still underweight in their adolescence (Wang *et al.* 2000). Early childhood
276 stunting also might be associated with disadvantages in late adolescence, including
277 deficits in cognition, school achievement, and even psychological functioning (Walker *et*
278 *al.* 2007). Thus, it is crucial to prevent early childhood malnutrition or the adverse effects
279 will persist, even in such a country experiencing improvement in nutrition as China.

280 We found that an additional one-third of children could be classified as stunted, but
281 1/6-1/3 of children who was underweight could not be classified when using the 2006
282 reference, compared to the 1978 reference. This feature seemed more evident in the child
283 population with a lower prevalence of malnutrition as rural western Chinese children
284 (Prost *et al.* 2008; Duggan 2010; Prinja, Thakur & Bhatia 2009). On a population scale,
285 using the 2006 reference could give the impression of an improvement in nutritional
286 status of Chinese children if previous data are not reanalyzed, especially when
287 underweight was used as an indicator. The results strongly suggested that a comparison of
288 period monitoring data on nutritional status of Chinese children should be cautious
289 because different references were possibly used.

290 The difference between the two references varied with age group. Irrespective of rural
291 children of western China or rural Tibetan children, such a changing pattern with age was
292 similar to that of Bangladeshi children, but the magnitude of change was quite different
293 (de Onis *et al.* 2006). Although our study also showed that the greatest difference in
294 malnutrition rates appeared during the first 6 months (de Onis *et al.* 2006; Prost et al.
295 2008; Prinja, Thakur & Bhatia 2009), the differences in our samples were much greater
296 than those in Bangladesh children (de Onis *et al.* 2006) but less compared with Malawian
297 children (Prost *et al.* 2008). Moreover, Tibetan children also presented a different
298 changing pattern with age compared with children of western China. It suggested the
299 impact of the 2006 reference on nutritional assessment varied markedly by index
300 populations. Tibetan children are a unique population who live at high altitudes > 3,000
301 m and have a unique traditional culture (Liu 1988). Previous studies in Tibet have shown
302 that high altitude might be an important and independent factor affecting the growth of
303 Tibetan children and could take effect before birth (Dang, Yan & Yamamoto 2008; Yip
304 1987; Moore *et al.* 2001). Thus, Tibetan children might have their own growth pattern,
305 which caused a different response to the two references. A comparative study also
306 showed that using two references resulted in different prevalence of malnutrition for India,
307 Peru and Vietnam (Fenn *et al.* 2008). The three countries have significant differences in
308 population characteristics and environmental and social measures, which might bring
309 about specific child growth patterns; such could also be true for China. A study among a
310 Hong Kong Chinese birth cohort suggested that such growth standards would not be
311 appropriate for Hong Kong Chinese children, or even the child population in East Asia
312 (Hui et al. 2008). A similar situation also was observed in UK child cohort (Wright et al.

313 2008). A previous study conducted among breastfed children from seven countries found
314 that growth patterns were “strikingly similar”, except for India and China (WHO
315 Working Group on the Growth Reference Protocol, Task Force on Methods for the
316 Natural Regulation of Fertility 2000); however, the MGRS did not include any infants
317 from China (de Onis et al. 2004). Therefore, we suggest that Chinese children might have
318 a specific growth pattern.

319 The prevalence of wasting was about 5%, suggesting that there are few children at risk
320 of acute malnutrition in rural western China. However, the introduction of the 2006
321 reference could further reduce identification of wasted children in our samples. In
322 addition to improvement of the food environment and child health, a possible reason that
323 must be considered is that the 2006 reference tends to underestimate height-for-age and
324 overestimate weight-for-age of rural children of China because our comparison between
325 two references was based on the same child population. In view of population-based
326 growth monitoring, using the 2006 reference could underestimate the level of acute
327 malnutrition of Chinese children, especially in poor areas.

328 The other implication was that the introduction of the 2006 reference could bring about
329 considerable differences in determination of malnutrition for rural Chinese children,
330 which would probably affect the formulation of nutritional intervention strategies in rural
331 China. Caution must be exercised when interpreting malnutrition rates derived from the
332 international growth reference for Chinese children. Perhaps a local growth reference
333 may be required.

334 The strength of this study was the application of random sampling and weighted
335 analysis adjusting for possible bias from the stratified multistage cluster random sampling

336 but some limitations have to be considered. The sample was from western China and
337 could not be representative of the entire Chinese child population. A smaller sample size
338 in younger age group, especially for Tibetan sample, may weaken the power of the study
339 because the first 6 months is a key time in growth trajectory. Anthropometric methods
340 were used in this study for estimating nutritional status of children at the population level.
341 They cannot determine completely whether an individual was really malnourished so
342 misclassification may arise. These methods may be inferior to a direct measurement of
343 body density as body fat percentage or skinfold thickness but are much more convenient
344 in population screening and some of them are correlated well with the body fat
345 percentage (WHO 1995; Mak *et al.* 2013). Despite these limitations, we believe that the
346 results are valuable because our study covered the key child growth phase (0-24 months)
347 and few studies have been conducted for a comparison of the two references in
348 assessment of malnutrition rates among young Chinese children.

349

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357

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361

362 **Conflicts of interest**

363 The authors declared no conflicts of interest.

364

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Table 1 Mean Z scores and percentage of children under 3 years of age who were stunted (height-for-age <-2 Z) underweight (weight-for-age <-2 Z), wasted (weight-for-height <-2 Z) by two growth references in rural western China and rural Tibet region*

Indicator	Rural western China			Rural Tibet region		
	1978 Reference	2006 Reference	Difference	1978 Reference	2006 Reference	Difference
Height-for-age						
Mean	-0.65	-0.83	-0.186	-1.21	-1.59	-0.226†
95% CI	[-0.681, -0.627]	[-0.861, -0.801]	[-0.191,-0.182]	[-1.312, -1.106]	[-1.701, -1.484]	[-0.233,-0.219]
Stunting(%)	12.3	17.9		28.1	37.5	
95% CI	[11.50, 13.00]	[17.05, 18.78]		[25.10, 31.20]	[34.05, 41.03]	
Weight-for-age						
Mean	-0.66	-0.49	0.158	-0.85	-0.72	0.145†
95% CI	[-0.691, -0.637]	[-0.512, -0.462]	[0.152,0.163]	[-0.933, -0.775]	[-0.791, -0.651]	[0.137,0.151]
Underweight(%)	11.7	7.7		15.3	13.1	
95% CI	[11.00, 12.30]	[7.19, 8.31]		[13.30, 17.60]	[11.16, 15.27]	
Weight-for-height						
Mean	-0.29	-0.06	0.229	-0.07	0.21	0.226
95% CI	[-0.324, -0.265]	[-0.093, -0.033]	[0.223,0.235]	[-0.154, 0.009]	[0.120, 0.294]	[0.217,0.235]
Wasting(%)	5.4	4.6		3.4	2.6	
95% CI	[4.90, 5.90]	[4.15, 5.01]		[2.50, 4.50]	[1.75, 3.88]	

* Weighted counts: n=12222 for rural western China, n=1344 for rural Tibet region

† Z-score mean differences between two reference in rural Tibet region was different significantly from those in rural western China by a mixed model controlling for sex, age, economic status, mother's education and altitudes (P<0.05).

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Table 2 Percentage of children under 3 years who were stunted (height-for-age <-2 Z), underweight (weight-for-age <-2 Z), wasted (weight-for-height <-2 Z) by two growth references by age in rural western China and rural Tibet region

Age in months	Rural western China				Rural Tibet region				Difference from Bangladesh % [§]
	n	1978 Reference	2006 Reference	Difference (%)	n	1978 Reference	2006 Reference	Difference (%)	
Stunting									
0-5	1612	3.4	6.9	3.5(+102.9)*	157	10.9	25.6	14.7(+134.9)*	+56.0
6-11	2700	8.7	11.0	2.3(+26.4)*	270	23.9	28.3	4.4(+18.4)*	+16.7
12-17	2312	14.4	17.7	3.3(+22.9)*	262	41.5	47.4	5.9(+14.2)*	+5.0†
18-23	2230	18.5	23.3	4.8(+25.9)*	229	32.7	41.3	8.6(+26.3)*	
24-29	1615	13.6	24.5	10.9(+80.1)*	236	25.8	38.9	13.1(+50.8)*	
30-35	1753	14.0	25.9	11.9(+85.0)*	190	26.8	40.1	13.3(+49.6)*	+16.7‡
Underweight									
0-5	1612	0.7	2.9	2.2(+314.3)*	157	2.7	4.0	1.3(+48.1)*	+135.3
6-11	2700	8.2	6.8	-1.4(-17.1)*	270	9.2	8.9	-0.3(-3.3)	-6.1
12-17	2312	15.6	8.2	-7.4(-47.4)*	262	23.3	14.5	-8.8(-37.8)*	-17.2†
18-23	2230	13.7	7.8	-5.9(-43.1)*	229	18.0	13.6	-4.4(-24.4)*	
24-29	1615	17.4	10.8	-6.6(-37.9)*	236	19.6	17.7	-1.9(-9.7)*	
30-35	1753	14.0	10.2	-3.8(-27.1)*	190	15.4	18.2	2.8(+18.2)	-14.5‡
Wasting									
0-5	1612	1.6	4.5	2.9(+181.3)*	157	2.1	1.0	-1.1(-52.4)*	+155.5
6-11	2700	4.2	4.7	0.5(+11.9)*	270	2.1	3.3	1.2(+57.1)*	+41.7
12-17	2312	9.1	5.9	-3.2(-35.2)*	262	5.6	3.0	-2.6(-46.4)*	
18-23	2230	7.2	3.5	-3.7(-51.4)*	229	3.9	2.0	-1.9(-48.7)*	-6.5†
24-29	1615	4.8	4.4	-0.4(-8.3)	236	3.3	3.2	-0.1(-3.0)	
30-35	1753	4.1	4.1	0(0)	190	2.5	2.4	-0.1(-4.0)	+13.3‡

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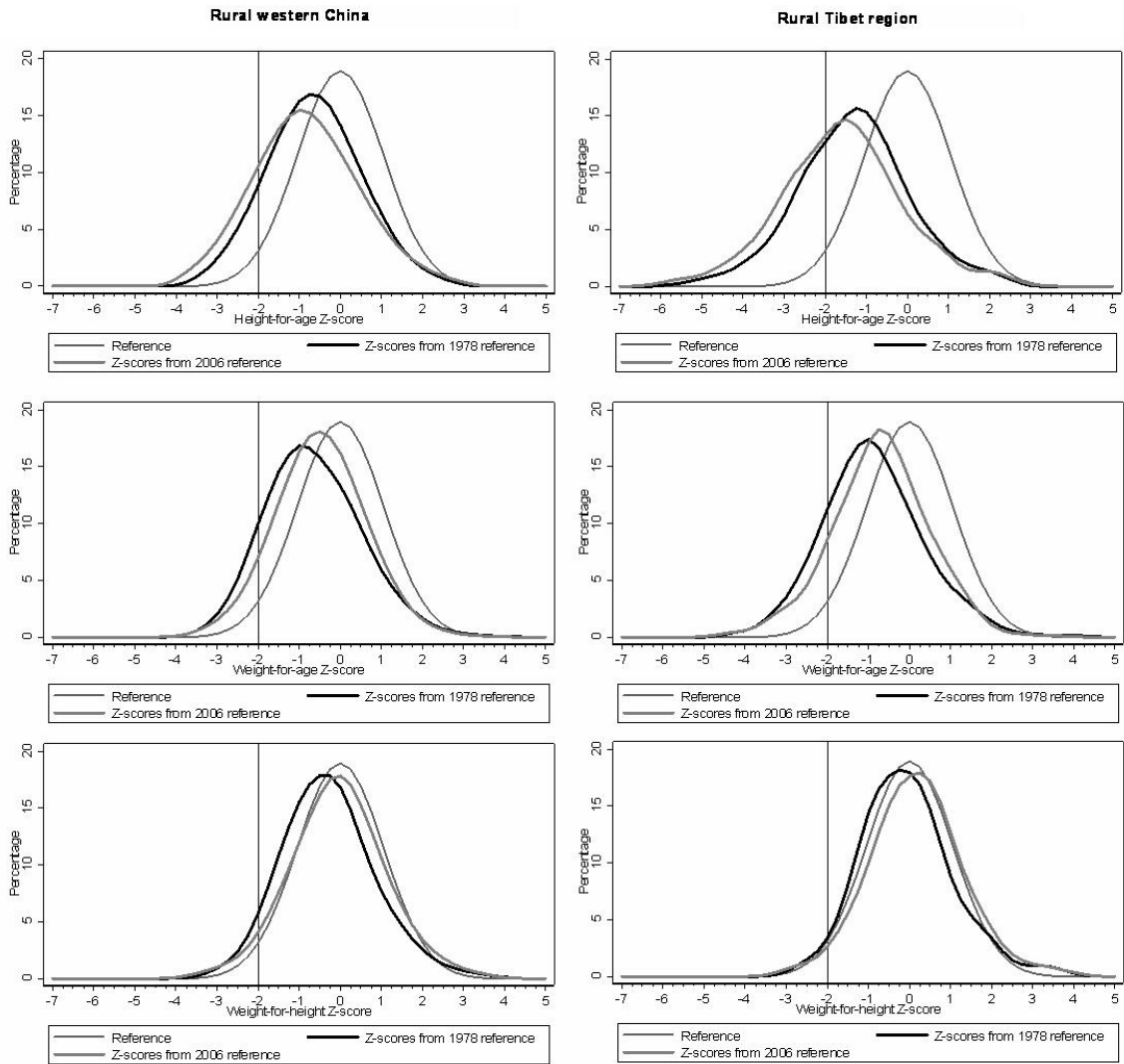
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Figure 1 Distribution of Z scores from two growth references in rural western China and rural Tibet region (Reference here refers to standard distribution of Z score)