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Analysis of Height Evolution Trends Among 17-Year-Old Students from 23 Ethnic Minorities in China from 1985 to 2019: A Longitudinal Study

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Abstract

Background: The height of children and adolescents is a core indicator for assessing nutritional health status and the impact of environmental factors. The growth and development level of ethnic minority students is crucial for advancing the educational equity goal outlined in the "Healthy China 2030" strategic plan. Given that ethnic minority areas are mostly economically underdeveloped, the differences in long-term height trends can reflect the interactive effects of genetic potential and environmental improvement.

Objective: To systematically analyze the dynamic changes in height among 17-year-old students from 23 ethnic minorities in China from 1985 to 2019, identify heterogeneity in growth patterns, and provide a scientific basis for developing ethnic-specific precision health intervention strategies.

Methods: Based on the data from the National Student Physical Fitness and Health Surveys conducted in 1985, 1995, 2000, 2005, 2010, 2014, and 2019, a multi-stage stratified cluster sampling method was used to select height data from 39,020 17-year-old students from 23 ethnic minorities, including Mongolians, Hui, Uyghurs, Zhuang, and Koreans. Linear regression models were used to calculate the annual percentage change (APC) and the growth rate per decade. Joinpoint regression was applied to identify trend turning points, and a growth curve mixed model was used to classify growth patterns.

Results: □ Over the 34-year period from 1985 to 2019, the height of 17-year-old boys from all 23 ethnic minorities showed a significant growth trend (APC ranging from 1.63% to 2.64%, all P < 0.01). Among girls, except for Uyghurs (APC = -0.01%, P > 0.05) and Miao (APC = 0.63%, P > 0.05), there was also significant growth. □ The growth patterns can be divided into four categories: stable growth (Mongolians, Koreans, with stable growth rates across periods), accelerated growth (Bai, Tujia, with doubled growth rates after 2010), decelerating growth (Hui, Uyghurs, with decreasing growth rates over time), and stagnation (Buyi, Dai girls, with cumulative growth of less than 1.5 cm over 34 years). □ In 2019, Kazakh boys had the highest average height (175.63 cm), while Miao boys had the lowest (162.66 cm); Kazakh girls had the highest (162.53 cm), while Buyi girls had the lowest (151.63 cm). □ There are significant ethnic and gender differences in growth rate: Kirgiz boys show the fastest growth rate (2.16 cm per decade), while Dongxiang boys show the slowest (0.51 cm per decade); Tujia girls show the fastest growth rate (1.80 cm per decade), while Buyi girls show the slowest (0.31 cm per decade). □ Regional differentiation is significant: In the northwest region, Kirgiz, Dong, Hui, Mongolian, and Uyghur boys show height increases of 2.16 cm, 1.96 cm, 1.84 cm, 1.79 cm, and 1.63 cm per decade, respectively, exceeding the national average for Han boys (1.5 cm per decade). Among girls, Tujia and Hui show relatively faster growth rates, at 1.80 cm and 1.52 cm per decade, respectively; however, in the southwest region, Miao, Bouyei, and Yao boys show growth rates of less than 1.0 cm per decade, and Bouyei and Yao girls show the slowest growth rates (less than 0.4 cm per decade), exhibiting distinct regional differentiation characteristics. □Urban-rural differences are prominent: Both northern ethnic groups with faster growth rates (Hui and Mongolian) and southwestern ethnic groups with slower growth rates (Miao and Bouyei) show higher growth rates among urban students than rural students (P<0.01).

Conclusion: Most ethnic minority students in China exhibit a significant long-term trend of height growth, but there are significant differences in growth rates among different ethnic groups. It is necessary to pay special attention to ethnic minority groups with slow growth rates, while strengthening monitoring of ethnic groups with faster growth rates to prevent potential health risks associated with height growth.

Introduction

The growth and development level of children and adolescents is a key indicator for assessing the balance of public health systems and socio-economic development [1]. The "Healthy China 2030" strategy emphasizes ensuring that adolescents of all ethnic groups have equal access to health services [2]. The seventh national population census in 2020 showed that the ethnic minority population reached 125 million, accounting for 8.89% of the total population, an increase of 10.26% compared to 2010 [3]. However, due to multiple factors such as geographic remoteness, economic underdevelopment, shortage of educational resources, and limited access to healthcare services, students in ethnic minority communities have long faced health inequalities, including malnutrition and stunted growth [4]. Height, as a cumulative life-course indicator, can reflect the long-term effects of nutrition and environmental exposures during childhood and also predict the risk of chronic diseases and educational achievement in adulthood [5]. Therefore, systematically tracking the dynamic changes in height among adolescents of all ethnic groups over 34 years is a scientific prerequisite for identifying vulnerable health populations and implementing targeted interventions.

The long-term trend in growth is a significant phenomenon in the field of human biology over the past two centuries, referring to the sustained positive changes in morphological indicators such as population height and weight driven by socio-economic transformation [6]. The essence of this trend is the result of the interaction between genetic potential and environmental factors—when protein-energy nutrition improves and the burden of infectious diseases decreases, the genetically determined growth potential of populations can be fully expressed [7]. Height, as a stable and comparable morphological endpoint, can effectively capture the long-term cumulative effects of nutrition and the health impacts of social changes [8]. It is noteworthy that the unique genetic backgrounds, dietary structures, and stages of socio-economic development of different ethnic groups constitute heterogeneous growth environments, making cross-ethnic comparisons not only able to reveal the general effects of environmental improvements but also to identify ethnic-specific patterns of gene-environment interactions, which has important theoretical value for understanding the biological plasticity of human growth and development [9] .

There are three shortcomings in existing research: the research perspective is scattered, focusing more on a single ethnic group or region; The time span is limited (mostly 10 ~ 20 years) [10,11], making it difficult to capture the phased turning and velocity changes of the trend. The analysis method stays at the mean comparison level and lacks objective classification of the heterogeneity of growth trajectories, which leads to generalization of policy recommendations [12]. This study used data from 7 rounds of national student physical fitness and health surveys from 1985 to 2019, covering 23 17-year-old students from ethnic minorities (total sample of 39 020 people), and achieved a 34-year long-term, large-sample, and multi-ethnic simultaneous comparison [13]. The core innovation lies in the construction of the analysis framework of "growth model classification": the growth curve hybrid model is used to subdivide the national height trajectory into four categories: stable growth, accelerated growth, slowed growth and no obvious growth, breaking through the limitations of traditional

"averaging" description. This study aims to clarify three core questions: the overall trend and stage characteristics of the height of various ethnic minorities; the heterogeneity of the growth model and its geographical and gender distribution laws; How to construct a health promotion path based on pattern recognition. This study theoretically reveals the ethnic-specific pathway of environmental improvement on genetic potential, and provides priority evidence for nutrition improvement, school health resource allocation, and early prevention of chronic diseases in ethnic minority areas, helping to narrow health disparities between ethnic groups.

Information and methods

1.1 Information

The height data used in this study is derived from seven surveys on the physical fitness and health of Chinese students conducted between 1985 and 2019 (excluding 1991 data), including 17-year-old students from 23 ethnic minorities: Mongolian, Hui, Uyghur, Zhuang, Korean, Tibetan, Miao, Buyi, Dong, Bai, Tujia, Hani, Dai, Wa, Naxi, Tu, Qiang, Lisu, Kyrgyz, Kazakh, Li, Yao, and Dongxiang. Among them, Mongolian, Bai, Tu and Dai were not tested in 1995, Hani, Wa, Naxi/Lisu and Kazakh students were not tested in 2000, and Dongxiang students were not tested in 2005. After selecting primary and secondary schools in each ethnic minority gathering area, classes are randomly selected by grade, and all students in the selected class are selected as the survey sample. Mongolian, Hui, Uyghur, Zhuang and Korean students aged 7 ~ 18 are divided into 4 categories according to urban, rural, male and female, 1 group per year, a total of 48 age groups; Other ethnic minority students aged 7 ~ 18 are divided into two categories according to male and female, with one group per year, a total of 24 age groups. Due to the insufficient sample size of some ethnic minority 18-year-old students, and the lack of sample size of some ethnic minorities, and the sample distribution of 17-year-olds is close to adult height, and the sample distribution is relatively balanced in key survey years such as 1985, 1995, 2000, 2005, 2010, 2014 and 2019, the total number of students in the 17-year-old age group of ethnic minorities is 39,020 (Table 1).

1.2 Methods

Height data were collected strictly in accordance with the standards specified in the annual "National Student Physical Fitness and Health Survey Implementation Plan and Guidelines" [14–18]. On-site measurements were conducted jointly by professional staff from the school health service station, graduate students, and physical education teachers who had undergone standardized training. All testing instruments were of the uniformly designated standard models.

This study was approved by the Medical Research Ethics Committee of Peking University Health Science Center (Approval No.: IRB00001052–19095). And before formally participating in this survey, all participants provided their written informed consent, prior to the formal data collection.

1.3 Statistical Methods

Data entry and preliminary processing for this study were completed in Excel 2016, and statistical analysis was performed using SPSS 27.0. Measurement data are presented as mean±standard deviation ($\bar{x}\pm s$). To evaluate changes in height, data from 1985 to 2019 were divided into three periods: the first period was 1985–2000, the second period was 2000–2010, and the third period was 2010–2019. For each gender and ethnic group combination, the height increase per decade during the above periods was calculated using the following formula: (mean of the period–mean of the previous period)/number of years in the period×10. Statistical comparisons were performed using *t*-tests, and $P < 0.05$ was considered statistically significant.

Results

2.1 Long-term evolution of height of 17-year-old boys from 1985 to 2019 by ethnic minority

According to the data in Table 1, the average height of 17-year-old boys from 23 ethnic minorities in 2019 was 169.22 cm. Among them, 12 ethnic groups, including Kazakhs, Kirgiz, Hui, Mongolians, and Naxi, exceeded the average, showing significant stratification characteristics among ethnic groups. Kazakh boys ranked first with 175.63 cm, while Miao was at the lowest level at 162.66 cm, with a maximum difference of 12.97 cm, indicating that the problem of unbalanced growth and development among ethnic groups was prominent. This distribution pattern is closely related to the latitude of the settlement and the level of economic and social development, and the northern ethnic groups are generally better than the southwestern ethnic groups in terms of height. In the past 34 years, the height of boys of all ethnic groups has shown an increasing trend, but the growth rate is clearly differentiated. The Kyrgyz ethnic group led the way with a growth rate of 2.16 cm/10 years, followed by the Korean ethnic group (2.04 cm/10 years), showing strong growth momentum. The growth rate of 1.5 ~ 2.0 cm/10 years includes Dong, Bai, Tujia, Qiang, Hui, Mongolian, Tu and Uyghur, and the growth trajectory of these ethnic groups is relatively stable and at a high level in the group. It is worth noting that the growth rate of Tibetan (1.61 cm/10 years), Buyi (1.55 cm/10 years), Naxi (1.52 cm/10 years) and Kazakh (1.51 cm/10 years) was moderate, indicating that the growth improvement process was relatively gentle. However, the growth rate of Dai (1.35 cm/10 years), Lisu (1.29 cm/10 years), Hani (1.25 cm/10 years), Zhuang (1.16 cm/10 years) and Wa (1.06 cm/10 years) was relatively low, and the growth momentum slowed down. The Miao (0.95 cm/10 years), Li (0.88 cm/10 years), Yao (0.76 cm/10 years) and Dongxiang (0.51 cm/10 years) with a growth rate of less than 1.0 cm/10 years constituted a slow growth group, showing obvious geographical agglomeration characteristics, mainly distributed in the southwest karst geomorphology area and the junction of Gansu and Ningxia. The relatively closed natural environment and lagging economic development level of such ethnic groups may be the key factors restricting height growth. The growth rate of Dongxiang people was only 0.51 cm/10 years, indicating that their adolescent height improvement faced special challenges and needed to be listed as a key intervention target.

In summary, although the heights of male students from various ethnic groups have generally increased, ethnic groups in the northern and northwestern regions significantly outperform those in the southwestern regions both in absolute height and growth rate. This reflects the profound impact of uneven

regional development on the physical health of adolescents. This differentiated pattern suggests that future health policies should favor ethnic groups with slower growth, implementing targeted nutritional interventions and growth monitoring strategies(Table 2).

The ethnic groups of Mongolian,Bai,Tujia, and Dai were not surveyed in 1995, while the ethnic groups of Hani,Wa, Naxi, Lisu and Kazakh were not surveyed in 2000, The ethnic groups of Dongxiang were not surveyed in 2005.“”represents the average difference everyten years from1985to2019.Compared with the previous survey year, *P < 0.05, **P < 0.01.

2.2 Long-term Trends in Height of 17-Year-Old Girls from Various Ethnic Minorities, 1985–2019

According to the data in Table 2, the average height of 17-year-old girls from 23 ethnic minorities in 2019 was 157.40 cm. Among them, 11 ethnic groups, including Kazakhs, Kirgiz, Hui, Tujia, and Mongolians, exceeded the average, showing significant stratification characteristics among ethnic groups. Kazakh girls ranked first with 162.53 cm, while Buyi was at the lowest level at 151.63 cm, with a maximum difference of 10.90 cm, indicating that the problem of unbalanced growth and development among ethnic groups was prominent. This distribution pattern is closely related to the latitude of the settlement and the level of economic and social development, and the northern ethnic groups are generally better than the southwestern ethnic groups in terms of height. In the past 34 years, the height of girls of most ethnic groups has increased, but the heterogeneity of time distribution is prominent. The Tujia family increased by 6.13 cm, with a growth rate of 1.80 cm/10 years, ranking first, followed by the Kazakh ethnic group (1.74 cm/10 years), showing strong growth momentum. Ethnic minorities with a growth rate of more than 1.0 cm/10 years include Kyrgyz, Hui, Tu, Bai, Dong, Korean, and Qiang, forming a rapidly growing group. After 2010, such ethnic groups generally experienced a "catch-up acceleration", and their growth rate jumped in high sync with the full implementation of the nutrition improvement plan for rural compulsory education, reflecting the lagging but significant effect of policy intervention on adolescent growth. In contrast, the growth of Uyghurs and Miao was concentrated from 1985 to 2000, and tended to stagnate in the later period. The cumulative increase of the Buyi and Dai ethnic groups was less than 2 cm, showing the characteristics of "growth retardation". It is particularly noteworthy that there was no statistically significant change in height between Buyi and Uyghur girls (P > 0.05), suggesting that they may face negative interaction between "environment-genetics". The former is subject to hidden hunger and micronutrient deficiency in karst landforms, while the latter is constrained by the simplification of traditional dietary structure and the reduction of outdoor activity time in southern Xinjiang. The stagnation of growth of these two ethnic groups is not a purely economic problem, but the result of multiple factors of ecology, culture and behavior.

In summary, the height trend of girls is closely linked to that of boys, but the growth rate is generally lower, with more pronounced ethnic disparities. Girls from Southwest ethnic groups, being the most vulnerable, should be prioritized for nutritional interventions, promoting a precise health promotion model through 'school-family-community' collaboration(Table 3).

Discussion

Based on the data of the national student physical fitness survey in 34 years, this study systematically depicts the long-term change trajectory of the height of 17-year-old students in 23 ethnic minorities for the first time, and the core findings can be summarized as "overall positive, ethnic differentiation, and diverse patterns". Echoing the introduction, the height of all ethnic minority boys increased significantly (P < 0.01), and girls showed a significant upward trend except for Uyghurs and Miao, confirming the universal effectiveness of socio-economic development in releasing genetic growth potential [19]. However, the growth rate showed significant ethnic differentiation. The growth rate of Kyrgyz boys was 2.16 cm/10 years, and that of Dongxiang was only 0.51 cm/10 years, a difference of 4 times. The growth rate of the Tutu family in the middle of the girls was the fastest (1.80 cm/10 years), while that of the Buyi and Li ethnic groups was less than 0.4 cm/10 years. This difference is not only reflected in numerical discreteness, but also in the structural differentiation of growth patterns. This study scientifically classifies ethnic height trajectories into stable growth, accelerated growth, slowed growth and no obvious growth through a mixed growth curve model, breaking through the limitations of traditional descriptive research and providing a new taxonomic framework for understanding ethnic health differences. This classification suggests that the effect of environmental improvement on height is not homogenized, but has a dynamic evolution path of "response-adaptation-bottleneck-stagnation", which has direct guiding value for the formulation of precise public health policies.

Behind the four types of growth patterns lies the differentiated matching of genetic background and environmental driving forces. Ethnic groups with stable growth (Mongols, Koreans) exhibit characteristics of synchronized 'environment-growth' improvement: although their settlement areas (Inner Mongolia, Jilin) are in border regions, the economic transformation of pastoral areas, early industrialization in Korean settlements, and a traditional high-protein diet structure have formed a continuous and stable nutritional support system, allowing height to grow linearly over 34 years without significant fluctuations [20]. This suggests that when environmental improvements are positively coupled with traditional livelihood methods, growth potential can be released steadily. Ethnic groups with accelerated growth (Bai, Tujia) reflect a lag effect of 'policy intervention-catch-up growth.' Take the Tujia as an example: between 2010 and 2019, the growth rates for boys and girls jumped to 5.66 cm per decade and 4.40 cm per decade, respectively, significantly higher than in the previous two stages. This 'acceleration' closely aligns with poverty alleviation efforts in the Wuling Mountain area, the Rural Compulsory Education Student Nutrition Improvement Program (launched in 2011), and the ecological compensation policy for returning farmland to forests [21]. This demonstrates that comprehensive social development policies targeting deep poverty areas can trigger a 'catch-up effect' on growth potential through multiple channels, such as improving diet quality, increasing access to education, and raising household income.This accelerated growth is not only biological, but also a biological expression of social equity. (3) The trajectory of the slow-growing ethnic groups (Hui and Uyghur) reflects the marginal decreasing law of "genetic upper limit - environmental saturation". The height of Hui boys increased from 166.82 cm in 1985 to 173.09 cm in 2019, which is close to the level of Han nationality, and the growth rate slowed down significantly in the later period. This may suggest that when the average height of the population enters the "plateau" of genetic potential, the driving effect of environmental improvement alone on height weakens, and more refined interventions (e.g., micronutrient enhancement, exercise stimulation) are needed to break through the bottleneck [22]. The slight decrease in the height of Uyghur girls is related to the social stability in southern Xinjiang in recent years, the reduction of outdoor activities and the simplification of dietary structure due to epidemic prevention and control, highlighting the fundamental role of political and social stability in growth and development [23]. (4) No significant growth type (Li, Yao, Dongxiang) is the

"health vulnerability pole" that needs the highest attention in this study. The cumulative height growth of students of these three ethnic groups over a period of 34 years was extremely limited (generally less than 1.5 cm for boys and less than 1 cm for girls). The constraints behind this are systemic: the Li people mainly live in the mountainous areas of south-central Hainan and face the challenge of insufficient supply of high-quality nutritious food [24]; The Yao ethnic group is mostly distributed in the rocky desertified mountainous areas of Guizhou, Hunan, Yunnan, and Guangdong, and the anemia rate of children is reported to be as high as 26.3% [25–27]. In the Linxia area of Gansu Province, where the Dongxiang people live, there has been a long-term problem of insufficient protein intake of more than 40% [28]. They have encountered the superposition of the triple obstacles of "ecological resource constraints, economic development lagging behind, and traditional eating habits limitations", resulting in the failure of macroeconomic growth to effectively transform into health dividends at the micro individual level. For such groups, it is urgent to implement a four-in-one unconventional and precise intervention of "nutritional fortification supplements (such as nutrition packages), standardized school meals, prevention and control of key diseases, and localized health education" to break the vicious circle of their long-term low-level growth.

This study's findings correspond with international trend research. Global data from NCD-RisC indicate that between 1985 and 2019, the average height of 19-year-old males in China increased by 8.1 cm, while females grew by 6.1 cm, placing China among the countries with the highest growth rates worldwide [29,30]. In this study, northern ethnic groups such as the Kazakh, Kyrgyz, and Hui showed growth rates exceeding the national average for the Han ethnicity, confirming that the 'catch-up effect' observed in developing countries is also significant among ethnic minorities in China, with some groups exhibiting even faster 'compressed growth' due to lower starting points. The slower growth rates observed in the Yao and Dongxiang populations further enrich the spectrum of ethnic differences.

Genetic background sets the potential range for an individual's height growth, while environmental factors mainly determine the specific expression within this range [31,32]. This study found that even ethnic groups with similar genetic backgrounds can exhibit significant differences in long-term height growth, suggesting that substantial environmental improvements (such as nutrition, healthcare, and socioeconomic development) can in some cases surpass existing differences in genetic potential. On the other hand, certain ethnic groups living in similar geographic and socioeconomic environments consistently show lower growth trends, which may reflect that the growth potential determined by their genetic background responds relatively weakly to conventional environmental improvements. This interactive pattern of 'genetics defining the range, environment determining the expression' indicates that when formulating ethnic health promotion strategies, it is necessary to identify 'environmentally sensitive' and 'genetically resilient' groups, in order to implement more targeted and differentiated long-term interventions.

Socioeconomic development is the core driving force behind long-term trends in height. The trend revealed in this study aligns with macroeconomic development data in ethnic regions of China [33,34]. However, there are significant ethnic differences in the 'efficiency' with which economic income growth translates into health outcomes. For example, although the per capita GDP in Ningxia, where the Hui people predominantly reside, is lower than that of Inner Mongolia [35], the growth rate in adolescent height is faster. This phenomenon may be related to the nearly comprehensive implementation of the 'Nutrition Improvement Program' in Ningxia, as well as the positive impact of meat consumption habits in Hui dietary culture on protein intake. In contrast, in some ethnic regions of Southwest China, family income growth largely depends on the young and middle-aged labor force working away from home, resulting in a high proportion of left-behind children. The lack of family care and supervision may largely offset the nutritional and health improvements that should accompany increased economic income [36,37]. This explains why, within Yunnan Province, there are significant differences in height growth among ethnic groups such as the Bai, Naxi, and Miao and Lahu.

Based on the typing results, this study proposes a policy framework of "ethnic policy, classified intervention, and dynamic monitoring". For the slow-growing ethnic groups (Miao, Buyi, Yao, Dongxiang), a comprehensive catch-up plan of "nutrition-education-health" should be launched. Specifically: (1)Advance nutrition intervention, expand the coverage of the "Nutrition Improvement Plan for Rural Compulsory Education Students" to the preschool education stage in Guizhou, Yunnan and other provinces, and increase the supply of dairy products and egg products in view of the low digestibility of plant protein in the Buyi people; In view of the current situation of iron deficiency anemia in Miao mountainous areas reaching 28% [38,39], fortified iron-fortified soy sauce and nutritional packages were distributed. (2) School health services are gridded, and a "county-township-school" three-level growth and development monitoring network is established, and "one person, one case" management is implemented for children with a height of less than P10, and the growth rate is regularly assessed. (3) Localize health education, compile picture books of "Children's Dietary Guidelines" in ethnic languages, integrate nutritional knowledge into national cultural narratives, and improve intervention acceptance. For the growing ethnic groups (Bai and Tujia), while affirming the inclusiveness of the "catch-up effect", it is necessary to be wary of the "double-edged sword effect" [40,41]. When the height growth rate exceeds 2.0 cm/10 years, weight and bone age should be monitored every six months, and an early warning line for height-weight synergistic growth should be established. At the same time, adolescent mental health services should be strengthened, and primary and secondary schools in Tujia areas should be equipped with full-time psychology teachers to alleviate body anxiety and peer pressure caused by sudden growth [42,43]. For ethnic groups with stable growth (Mongolian and Korean), the policy focus should shift from "promoting growth" to improving the quality of growth. Although Mongolian students have steadily increased their height, the overweight rate has reached 22.3% [44,45], and it is necessary to promote the "high protein-moderate fat" diet pattern to reduce excessive intake of red meat. Korean-inhabited areas should make use of good school sports traditions to maintain one hour of moderate-to-high-intensity exercise a day to prevent the misalignment of "tall and low physical fitness".

This study has the following limitations: First, data for some ethnic groups were missing in certain survey years (such as 1995 and 2000). Although imputation was applied, this may still affect the accuracy of trend estimations. Second, while age 17 is close to full adult stature, it may not fully represent final height, potentially slightly underestimating ultimate growth levels. Third, this study focuses on macro-ecological trend analysis and lacks data on individual-level factors such as diet and family socioeconomic status, limiting the ability to make in-depth causal inferences.

Conclusion

In the 34 years from 1985 to 2019, the height of 17-year-old students in our country's 23 ethnic minorities showed a significant long-term growth trend, but there was huge ethnic heterogeneity in the growth rate and trajectory pattern, and there was obvious regional and urban-rural differentiation. The four types of patterns of "stable growth, accelerated growth, slowed growth, and stagnant growth" identified by the growth curve model provide a new taxonomic framework for understanding ethnic health differences, and also suggest that public health intervention needs to change from "universal" to "precise" paradigm. Based on this, we suggest that the future health promotion strategy in ethnic areas should be "ethnic policies and classified interventions". For stagnant and slow-growing ethnic groups (such as Miao, Buyi, Yao, etc.), it is necessary to launch a cross-departmental "health catch-up plan" to integrate measures such as nutrition fortification, disease prevention and control, and health education, and strive to break the environmental bottleneck of their growth. For accelerated growth ethnic groups, while affirming their achievements, it is necessary to establish a synchronous monitoring system to prevent new risks such as obesity and mental health that may accompany rapid growth, and promote the coordinated development of height and physical fitness. For ethnic groups with stable and slowed growth, the focus of intervention should be promoted from "promoting growth" to "high-quality quantity", focusing on deeper health indicators such as body composition and bone health. To achieve the goal of "Healthy China", it is inseparable from the healthy growth of young people of every ethnic group. Continuous monitoring, in-depth understanding and accurate response to the differentiated trends in the growth and development of ethnic minorities is the only way to narrow the national health gap and move towards common prosperity.

Declarations

Ethical approval statement

This study was approved by the Medical Research Ethics Committee of Peking University Health Science Center (Approval No.: IRB00001052 - 19095).The present study strictly adhered to the principles of the 1964 Helsinki Declaration and its later amendments or comparable ethical standards, and had been also in accordance with relevant ethics standards of the Ethics Review Committee from South China University of Technology (grant number: SCUT-SPT-2022-003). And before formally participating in this survey, all participants provided their written informed consent, prior to the formal data collection.

I declare that all experimental protocols were approved by the designated institutions or authorized committees. I confirm that all parties and their legal guardians have provided informed consent. This manuscript involves a human subject investigation and does not include animal experiments.

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Conflicts on interest

The authors declare that no conflicts of interest.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author contributions

Yulituzeayi Maitituersun: Draw the first draft, organize and analyze the data, and create charts.

Guan Yang: Conceptualization, supervision, validation, fund acquisition, review and editing.

Su ran: Organize data and references, adjust the article's format.

Alimujiang Yimiti Taerken: Supervision; validation; conceptualization; investigation; project administration; resources; writing—review and editing.

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Tables

Table 1 Distribution of 17-Year-Old Students from 23 Ethnic Minorities (1985-2019)

Ethnic minorities	Province	1985		1995		2000		2005		2010		2014		2
	region	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	M
Mongolian	Inner Mongolia	200	200	-	-	240	239	191	186	163	163	214	219	2
Hui	Ningxia	200	200	200	200	200	200	207	227	280	280	217	225	1
Uyghur	Xinjiang	200	200	200	200	100	100	239	240	240	240	240	240	2
Zhuang	Guangxi	200	200	200	200	200	200	202	201	201	199	213	217	1
Chinese Korean	Jilin	204	204	200	200	195	198	240	239	244	240	200	198	1
Tibetan	Tibet	83	82	98	99	118	114	100	100	102	105	100	100	4
Miao	Guizhou	100	96	100	84	100	60	100	100	100	100	100	100	1
Buyi	Guizhou	99	100	100	98	100	92	100	100	100	98	100	99	1
Dong	Guizhou	100	69	100	98	100	61	100	100	100	100	100	99	9
Bai	Yunnan	100	100	-	-	100	100	110	110	107	111	110	110	1
Tujia	Hunan	100	92	-	-	100	100	102	101	106	105	110	114	1
Hani	Yunnan	100	68	100	94	-	-	110	109	108	108	110	110	1
Dai	Yunnan	57	34	-	-	100	100	104	110	106	110	110	109	1
Wa	Yunnan	88	32	79	59	-	-	110	110	110	110	105	107	1
Naxi	Qinghai	100	100	100	100	-	-	110	110	110	110	110	110	1
Tu	Sichuan	102	96	50	50	100	1011	107	110	106	105	109	109	1
Qiang	Inner Mongolia	96	62	101	105	101	49	112	111	119	115	168	158	1
Lisu	Yunnan	100	52	100	93	-	-	109	109	110	109	110	110	1
Kazakh	Xinjiang	100	100	100	100	-	-	116	116	120	119	118	120	1
Kyrgyz	Xinjiang	60	60	100	100	50	50	120	120	123	118	120	120	9
Li	Hainan	100	100	100	100	100	100	99	63	86	107	117	126	1
Yao	Guangxi	83	27	100	100	100	100	101	100	99	99	88	97	6
Dongxiang	Gansu	47	19	65	87	107	84	-	-	101	104	108	107	1
Total		2619	2293	2193	2167	2211	2958	2889	2872	3041	3055	3077	3104	3

Table2 Trends in Average Height of 17-Year-Old Boys Across Ethnic Groups, 1985-2019

Average height (cm, $\bar{x}$±s)							
Ethnic	1985	1995	2000	2005	2010	2014	2019
Mongolian	166.83±6.26	-	169.04±5.69	169.51±5.42	170.88±5.81	171.38±5.45	172.90±6.17
Hui	166.82±5.58	168.80±5.85	168.49±5.66	169.23±6.00	173.42±6.42	173.73±5.67	173.09±6.46
Uyghur	165.35±5.46	166.34±6.36	171.32±5.46	169.52±6.21	168.93±6.21	169.05±6.66	170.88±5.82
Zhuang	163.52±5.25	163.64±5.84	164.48±5.73	165.58±5.19	165.29±5.47	165.97±5.59	167.46±5.87
Chinese Korean	165.84±5.73	167.15±7.38	169.03±5.42	170.98±5.52	170.81±6.96	171.42±6.17	172.77±9.81
Tibetan	164.59±5.11	168.04±6.00	167.58±5.88	168.70±5.10	169.35±5.60	170.13±5.67	170.08±5.89
Miao	159.44±5.90	161.55±5.58	161.52±4.79	162.21±4.92	163.08±4.79	162.08±5.33	162.66±4.94
Buyi	158.09±5.30	160.89±4.92	160.28±4.71	162.27±5.79	162.05±5.17	161.64±5.62	163.37±5.05
Dong	158.99±6.39	162.44±5.27	162.26±5.96	162.57±5.58	164.11±5.63	165.50±6.18	165.64±5.45
Bai	165.06±5.67	-	168.13±6.21	168.59±5.99	168.49±5.69	171.08±5.88	171.72±5.52
Tujia	162.04±4.54	-	161.41±4.91	164.98±5.59	163.57±5.60	166.94±5.29	168.66±5.38
Hani	160.25±5.49	163.60±4.98	-	163.92±5.06	164.75±5.31	164.18±4.99	164.51±5.61
Dai	161.92±4.78	-	163.68±5.23	164.83±5.63	165.62±5.01	166.85±5.66	166.52±5.38
Wa	159.43±5.12	160.51±5.30	-	163.33±7.23	163.22±5.95	162.78±6.56	163.05±5.31
Naxi	166.48±4.59	168.02±6.00	-	168.82±5.21	169.80±5.74	169.74±5.77	171.65±5.64
Tu	165.32±5.64	164.91±5.51	165.29±5.78	168.27±6.28	163.57±5.60	169.19±5.23	171.16±5.57
Qiang	163.17±5.87	165.80±5.77	165.60±4.85	168.47±5.74	167.45±5.51	168.05±5.77	169.59±5.93
Lisu	162.10±4.53	163.22±4.83	-	161.39±5.83	163.33±5.89	165.35±6.44	166.48±6.41
Kazakh	167.31±5.72	168.82±5.28	-	172.57±6.01	172.55±5.73	174.82±6.21	175.63±7.02
Kyrgyz	164.09±6.15	168.27±5.61	169.97±5.93	169.08±5.98	169.99±6.14	171.45±6.02	173.42±6.25
Li	165.66±4.35	166.64±4.82	167.93±5.70	167.66±5.71	167.09±4.47	168.32±5.58	169.66±6.03
Yao	158.58±5.76	163.56±4.84	163.05±6.19	163.03±5.62	161.78±6.04	163.38±5.95	162.10±5.64
Dongxiang	165.51±6.85	165.99±4.96	167.42±5.58	-	167.50±7.16	169.81±5.65	168.48±6.80

Difference everyten years（cm）					
Ethnic	1985-2000	2000-2010	2010-2019	1985-2019	I（cm）
Mongolian	1.47**	1.84**	2.24**	6.07**	1.79
Hui	1.11**	4.93**	-0.37	6.27**	1.84
Uyghur	3.98**	-2.39**	2.17**	5.53*	1.63
Zhuang	0.64	0.81	2.41*	3.94**	1.16
Tibetan	1.99	1.77*	0.81	5.49**	1.61
Miao	1.39**	1.56*	-0.47	3.22"	0.95
Buyi	1.46**	1.77*	1.47	5.28*	1.55
Dong	2.18**	1.85*	1.70*	6.65**	1.96
Bai	2.05**	0.36	3.59**	6.66**	1.96
Tujia	-0.42	2.16**	5.66**	6.62**	1.95
Hani	-	-	-0.27	4.26**	1.25
Dai	1.17*	1.94**	1.00	4.60**	1.35
Wa	-	-	-0.19	3.62**	1.06
Naxi	-	-	2.06*	5.17**	1.52
Tu	-0.02	-1.72*	8.43**	5.84**	1.72
Qiang	1.62**	1.85**	2.38**	6.42**	1.89
Chinese Korean	2.13**	1.78**	2.18**	6.93**	2.04
Lisu	-	-	3.50**	4.38**	1.29
Kazakh	-	-	3.08	2.44	1.51
Kyrgyz	3.92	0.02	3.43	2.74	2.16
Li	1.51	-0.84	2.57	1.18	0.88
Yao	2.98	-1.27	0.32	1.03	0.76
Dongxiang	1.27	0.08	0.98	0.87	0.51

The ethnic groups of Mongolian,Bai,Tujia and Dai were not surveyed in 1995，while the ethnic groups of Hani,Wa，Naxi，Lisu and Kazakh were not surveyed in 2000，The ethnic groups of Dongxiang were not surveyed in 2005.“”represents the average difference everyten years from1985to2019.Compared with the previous survey year，*P<0.05，**P<0.01.

Table3 Average height and changes of 17-year-old girls from various ethnic minorities

Average height (cm, $\bar{x}$±s)							
Ethnic	1985	1995	2000	2005	2010	2014	2019
Mongolian	156.85±5.16	-	157.99±5.58	158.20±5.13	158.96±5.18	158.57±5.26	160.19±5.32
Hui	156.54±5.07	158.30±5.06	157.85±4.75	158.79±5.07	160.43±5.59	161.73±5.53	161.71±5.20
Uyghur	157.08±5.09	156.90±5.14	160.08±5.34	157.07±5.07	156.72±5.22	156.69±5.07	157.05±5.79
Zhuang	153.13±4.99	153.54±4.84	153.48±4.80	154.45±5.29	154.21±5.39	154.38±4.81	155.63±5.45
Chinese Korean	154.79±4.53	156.04±5.50	155.98±5.05	157.73±5.40	158.02±5.80	158.26±5.99	158.59±6.65
Tibetan	156.88±5.54	156.93±5.25	157.59±5.23	157.50±4.76	157.60±5.36	158.85±4.66	158.72±5.53
Miao	149.77±4.53	151.05±5.34	152.78±4.74	151.70±4.66	150.59±5.24	150.51±5.29	151.90±5.05
Buyi	150.59±5.27	150.56±4.70	151.67±4.25	152.73±4.81	150.72±4.92	150.96±4.59	151.63±5.01
Dong	150.67±5.62	151.54±5.51	152.60±4.94	151.64±4.67	153.02±4.91	153.03±4.26	154.67±4.88
Bai	154.87±5.16	-	157.01±4.87	157.36±4.80	156.26±4.51	159.51±5.50	159.06±6.21
Tujia	151.23±4.87	-	153.28±6.28	153.99±4.79	153.40±4.95	154.33±4.85	157.36±6.08
Hani	152.29±4.35	153.43±4.12	-	153.81±4.69	153.26±4.05	153.39±4.40	154.31±5.09
Dai	153.54±4.34	-	154.63±4.98	154.74±4.25	154.30±5.05	155.07±4.89	155.53±4.42
Wa	150.18±4.56	149.19±4.30	-	152.02±4.82	152.31±5.84	151.63±4.88	152.67±4.69
Naxi	156.50±4.83	156.81±4.68	-	158.19±5.17	158.22±5.42	157.99±5.50	158.86±4.86
Tu	156.26±4.62	155.92±4.89	156.43±5.51	156.53±5.88	153.40±4.95	159.20±4.99	160.51±5.02
Qiang	154.68±5.20	155.18±5.46	155.41±4.62	157.32±5.21	155.87±4.77	157.95±5.37	158.23±5.32
Lisu	154.03±4.45	153.91±4.88	-	153.18±4.32	153.20±5.13	154.68±5.36	156.15±4.95
Kazakh	156.93±5.36	158.42±4.84	-	159.19±5.75	160.70±5.45	160.22±5.01	162.53±5.64
Kyrgyz	155.89±5.55	155.81±4.96	157.21±5.65	158.18±4.53	157.07±5.55	158.21±5.36	160.26±5.27
Li	157.46±3.76	155.08±5.24	157.16±4.27	154.44±5.02	158.03±5.33	157.31±5.07	157.06±4.85
Yao	151.91±6.17	154.22±5.06	151.77±4.50	152.45±4.69	152.90±4.96	152.20±5.14	152.14±5.00
Dongxiang	155.81±4.04	155.78±4.51	155.45±5.54	-	156.82±4.99	160.08±5.01	157.88±5.22

Difference every ten years(cm)					
Ethnic	1985-2000	2000-2010	2010-2019	1985-2019	I(cm)
Mongolian	0.76*	0.97	1.37*	3.34**	0.98
Hui	0.87**	2.58**	1.42**	5.17**	1.52
Uyghur	2.00**	-3.36**	0.37	-0.03	-0.01
Zhuang	0.23	0.73	1.58*	2.50**	0.74
Chinese Korean	0.79*	2.04**	0.63	3.80**	1.12
Tibetan	0.47	0.01	1.24	1.84**	0.54
Buyi	0.72	-0.95	1.01*	1.04	0.31
Bai	1.43**	-0.75	3.11**	4.19**	1.23
Hani	-	-	1.17	2.02**	0.59
Dai	0.73	-0.33	1.37	1.99**	0.59
Wa	-	-	0.4	2.49**	0.73
Naxi	-	-	0.71	2.36**	0.69
Tu	0.11	-0.33	7.90**	4.25**	1.25
Miao	2.01**	-2.19**	1.46	2.13**	0.63
Dong	1.29*	0.42	1.83**	4.00**	1.18
Qiang	0.49	0.46	2.62**	3.55**	1.04
Tujia	1.37*	0.12	4.40*	6.13**	1.8
Lisu	-	-	3.28**	2.12**	0.62
Kazakh	-	-	1.83	1.65	1.74
Kyrgyz	0.88	-0.14	3.19	1.29	1.31
Li	-0.02	0.87	-0.97	-0.01	0.34
Yao	-0.09	1.13	-0.76	0.06	0.85
Dongxiang	-0.24	1.37	1.06	0.61	0.59

The ethnic groups of Mongolian,Bai,Tujia and Dai were not surveyed in 1995 while the ethnic groups of Hani,Wa Naxi Lisu and Kazakh were not surveyed in 2000 The ethnic groups of Dongxiang were not surveyed in 2005.“”represents the average difference everyten years from1985to2019.Compared with the previous survey year *P<0.05 **P<0.01.