

# Analysis of Urine Test Results of Han and Tibetan 0-6 Years Old Children in Gansu Province, Western China: A Cross-Sectional Study

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## Research article

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# Abstract

## Background

Urine examination can reflect concealed kidney diseases in children. However, few surveys described the difference in urine routine indicators between children belonging to different ethnic groups. This study aimed to compare urine components between Han and Tibetan preschool children in western China and explore influencing factors for early kidney disease prevention.

## Methods

The urine routine data were obtained by cluster sampling of children ( $N = 1645$ :  $N_{\text{Han}} = 1019$ ,  $N_{\text{Tibetan}} = 626$ , age range: 0–6 years) in 10 child care institutions of Lanzhou City and Gannan Tibetan Autonomous Prefecture through the medical examination center affiliated to a top three hospital in Gansu Province in western China. The correlation of the urine routine indicators with the factors, including living environment, diet, family income, and kidney disease in parents, were explored through multiple logistic regression analysis.

## Results

The lower age group (1–3 years old) was a protective factor for urinary vitamin C in Han children [odds ratio (OR)<sub>Han</sub> = 0.13, 95% confidence interval (CI) = 0.05–0.32], while it was a risk factor among Tibetan children (OR<sub>Tibetan</sub> = 3.01, 95% CI = 1.28–7.10), compared with the higher age group (4–6 years old). Among Han children, male sex was the risk factor for urinary ketone body (OR<sub>Han</sub> = 2.28, 95% CI = 1.20–4.33). Among Tibetan children, living in newly decorated houses was a risk factor for urinary ketone body and urinary occult blood (OR<sub>ketone body</sub> = 2.35, 95% CI = 1.12–4.93; OR<sub>occult blood</sub> = 18.20, 95% CI = 4.30–76.92). Male sex is the protective factor for urinary leukocyte detection in both Han and Tibetan children (OR<sub>Han</sub> = 0.10, 95% CI = 0.04–0.20; OR<sub>Tibetan</sub> = 0.25, 95% CI = 0.10–0.63). The intake of lead-containing foods is a risk factor for urinary leukocyte detection in Tibetan children (OR<sub>Tibetan</sub> = 4.34, 95% CI = 1.19–15.91). Parental kidney disease history is a risk factor for urinary occult blood in Han children (OR<sub>Han</sub> = 2.56, 95% CI = 1.21–5.41).

## Conclusion

The differences in physiology, diet, and living environment in children belonging to different ethnic groups were influencing factors for different urine abnormalities.

## Background

Kidney disease has been described as the most neglected chronic disease [1]. Chronic kidney disease has posed serious health damage and a heavy economic burden on human beings. Kidney disease in children often occurs insidiously and may develop into chronic nephropathy [2]. The incidence and morbidity of

kidney disease in children tend to increase [3]. Urine examination can better reflect kidney and urinary system diseases, which is an important means for the early detection of kidney disease [4]. As early as in the 1960s and 1970s, developed countries such as Japan, South Korea, and Singapore used urine screening for primary and secondary school students as one of the measures for children's health. The detection rate of latent nephropathy in local children improved [5]. Routine urine examination has been used as an early screening and prognostic measure for kidney diseases in many countries around the world [6] [7] [8] [9]. In Asia, Japan, South Korea, Taiwan, and China have launched a regular urine screening program for children and adolescents [10] [11] [12]. China's western region is sparsely populated, and its economic development is lagging behind. Ethnic and frontier areas are two main characteristics of the region. In these places, Tibetans, who are characterized by high-altitude living and Buddhism, are different from Han in terms of diet, lifestyle, and cultural characteristics [13]. Using regular urine tests, this study examined the morning urine of children aged 0–6 years in Lanzhou City and Gannan Tibetan Autonomous Prefecture in Gansu Province in western China. The study was performed to compare the abnormal urine status of Han and Tibetan preschool children so as to explore the possible factors for urine abnormalities in children and hence help in the early prevention and treatment of chronic kidney disease in children in different ethnic groups.

## **Methods**

### **Data sources and design**

The laboratory data of urine components were obtained from the medical examination center of a top 3 hospital in Gansu Province in western China during the period 2015–2017 by cluster sampling of children aged 0–6 years in 10 child care institutions of Lanzhou City and 5 child care institutions of Gannan Tibetan Autonomous Prefecture. General epidemiological data were obtained through a quantitative questionnaire survey on parents of children who visited the physical examination center.

### **Urine routine test**

The urine samples of children visiting the outpatient clinic were taken for a routine urine examination using a dry chemical analyzer and urine sediment detection [4]. The morning mid-stage urine was collected and tested immediately after on-site collection by unified training testing staff using a unified standard method so as to control the quality of urine examination.

### **Information collection using the questionnaire**

The children were surveyed using the questionnaire designed by the research group. The contents of the questionnaire comprised the children's personal status, environmental exposure, diet, parents' age, parents' education level, parents' income status and parents' history of kidney disease. These parents filled the questionnaire, and the investigator on the spot checked and collected the questionnaire.

### **Statistical analysis**

Important indicators of the detection rate of urine in the two ethnic groups of children were analyzed by case-control analysis. Children with abnormal urine test results formed the case group. Children with negative test results formed the control group (case:control = 1:3; vitamin C level 1:1). The correlations between abnormal urine results and the following factors were analyzed: personal conditions (body mass index, BMI), environmental exposure (harmful environmental factors including heavy metals, pesticides, chemicals, high temperature, high humidity, electromagnetic radiation, noise, and so on). "Frequently passive smoking" meant that the same occupants smoked more than one time per day for more than 15 min in the children's living environment. "Residing in newly decorated houses" meant that the children lived in newly renovated houses within 1 year before and after birth, and the dietary status ("food intake") was determined by comparison with peers. "Frequent intake of lead-containing foods" referred to eating lead-containing pine eggs, popcorn, and animal offal more than two times a week).

### **Diagnostic criteria**

Urine vitamin C, protein, red blood cells, white blood cells, nitrite, glucose, bilirubin, urobilinogen, ketone bodies, and so forth are semi-quantitative indicators divided into "-", "+", "++", and "+++." IA detection Indicator with one or more "+" is defined as positive. The occult blood-positive patients were examined by urinary sediment microscopy. The red blood cells more than 3/HP (per high-power field) indicated a positive result. The white blood cell-positive patients were reviewed by urinary sediment microscopy, and the standard was more than 5/HP.

### **Statistical analysis**

The database was built using Epidata3.1 data management software, and the occurrence of an abnormal urine test in Han and Tibetan children was described using SPSS22.0 and EXCEL2010. The differential detection of the indicators between the two ethnic groups was conducted using the  $\chi^2$  test. The multivariate logistic regression analysis was used to explore the possible influencing factors for abnormal urine. The case group comprised children with abnormal urine test results. The control group comprised children with normal urine test results. The detection results of indicators revealed that the ratio of the sample of the case group to the sample of the control group was 1:3, but it was 1:1 for the vitamin C level.

## **Results**

### **Basic condition of the participants**

A total of 1645 children were examined, including 1019 (61.95%) Han and 626 (38.05%) Tibetan. Further, 582 boys (57.11%), and 437 girls (42.89%) were Han; 342 boys (54.63%) and 284 girls (45.37%) were Tibetan. Among Han children, those aged <1 year accounted for 5.00% (51/1019), those aged 1-3 years accounted for 51.13% (521/1019), and those aged 4-6 years accounted for 43.87% (447/1019). Among Tibetan children, those aged <1 year accounted for 24.12% (151/626), those aged 1-3 years accounted

for 50.48% (316/626), and those aged 4–6 years accounted for 25.40% (159/626). The height and weight of male and female children of different ages in different ethnic groups are shown in Table 1.

### Urine test results of the participants

Among the 1019 Han children undergoing routine urine testing, 709 had abnormal test results. The positive detection rate of the top 5 indicators was as follows: urinary vitamin C, 421 children (41.32%); urinary white blood cells, 75 children (7.36%); urinary gallbladder, 67 children (6.58%); ketone bodies, 61 children (5.99%); and occult blood, 56 children (5.50%). Among the 626 Tibetan children undergoing routine urine testing, 325 had abnormal test results. The positive detection rate of the top 5 indicators was as follows: urinary vitamin C, 114 (18.21%); urine ketone body, 110 (17.57%); and urine occult blood, 47 (7.51%). Further, 38 (6.07%) and 37 (5.91%) children had positive results for urinary urobilinogen and white blood cells, respectively. The positive detection rates of top five indicators among boys and girls are shown in Table 2 .

The positive detection rate of urine vitamin C in Han and Tibetan children was 41.32% and 18.21%, respectively, with a statistically significant difference ( $P < 0.001$ ). The positive detection rate of ketone bodies was 5.99% and 17.57%, respectively, with a statistically significant difference ( $P < 0.001$ ). The positive detection rate of urinary bilirubin was 2.06% and 0.80%, respectively, with a statistically significant difference ( $P = 0.046$ ). The detection rate of urinary protein was 0.39% and 3.83%, respectively, with a statistically significant difference ( $P < 0.001$ ). The abnormal detection rate of other indicators among children in the two ethnic groups was not statistically significantly different, as shown in Table 3.

The results of multivariate logistic regression analysis showed that the detection rate of urine vitamin C in Han boys was 1.385 times that in girls (95% CI = 1.041–1.842). Among Han children, the positive detection rate of urine vitamin C in the 1-year-old group was lower than that in the 4- to 6-year-old group (OR = 0.208, 95% CI = 0.086–0.507); and the rate in the 1- to 3-year-old group was lower than that in the 4- to 6-year-old group (OR = 0.128, 95% CI = 0.052–0.313). Parents' histories of kidney disease was a risk factor (OR = 2.506, 95% CI = 1.661–3.781). In Tibetan children, the positive detection rate of urine vitamin C in the 1- to 3-year-old group was higher than that in the 4- to 6-year-old group (OR = 3.011, 95% CI = 1.277–7.096); living in the passive smoking environment was a risk factor for urine vitamin C (OR = 1.919, 95% CI = 1.102–3.340). The detection rate of urine ketone body in Han boys was 2.283 times that in girls (95% CI = 1.203–4.333). In Tibetan children, age, lead-containing foods, and living in newly decorated houses for a long time were influencing factors for the urine ketone body. The detection rate of urinary white blood cells in boys of both ethnic groups was lower than that in girls (OR<sub>Han</sub> = 0.095, 95% CI = 0.044–0.204; OR<sub>Tibetan</sub> = 0.253, 95% CI = 0.101–0.633). The detection rate of white blood cells in Tibetan children consuming lead-containing foods was high (OR = 4.342, 95% CI = 1.185–15.906). The detection rate of urinary occult blood in Tibetan children aged 1–3 years was lower than that in children aged 4–6-years (OR = 0.050, 95% CI = 0.009–0.277). Parents' histories of kidney disease (OR = 2.561, 95% CI = 1.213–5.408) and living in newly decorated houses for a long time were risk factors (OR = 18.203, 95% CI = 4.308–76.924), as shown in Table 4.

## Discussion

Routine urine tests have been conducted in a few developed cities in China for children with chronic occult kidney disease. However, data among children from ethnic minority areas in western China are rarely reported. Urine white blood cells, urine occult blood, and urine protein are commonly used to initially detect and analyze the occurrence of latent nephropathy in children. A comparison of urine test results of Han and Tibetan children revealed that the detection rate of urinary protein was higher in Tibetan children than in Han children. In this study, for urinary protein, the multivariate analysis was not carried out because of fewer children with positive results for urinary protein. The influencing factors for urine protein detection in the two ethnic groups need further exploration.

Other multivariate regression analysis showed that male sex was a protective factor for urinary white blood cells, which might be related to girls' short urethra, urethral opening close to the anus, and easy contamination by feces, causing urinary tract infection. The results of this study showed that "frequent intake of lead-containing foods" was a risk factor for urinary white blood cells in Tibetan children. At present, few studies have been conducted on the correlation between urinary white blood cells and lead exposure [14]. The ability of kidneys to resist inflammation caused by blood-borne pathogens might be weakened by the effect of lead intake on kidney structure and function [15]. However, since blood-borne infections account for less than 3% of urinary tract infections, the influence of lead intake on kidney needs further confirmation.

Male sex is a protective factor for urinary white blood cells in both Han and Tibetan children [16].

Urinary occult blood is mainly used for the diagnosis of kidney and urinary tract diseases [17]. The present study showed that a history of parental kidney disease was the risk factor for urinary occult blood found in Han children [18]. Age 4–6 years and "residence in newly decorated houses" were the risk factors for urinary occult blood in Tibetans. Newly decorated houses contain harmful chemical substances such as formaldehyde and benzene series. Toxicological studies have shown that gaseous formaldehyde can cause obvious oxidative damage to kidney tissue [19][20]. Increased exposure to environmental risk factors increases the positive detection rate of urinary occult blood in growing children.

The nutritional status is essential for healthy kidneys in children [21]. The present study found that the positive rate of urinary vitamin C was higher in Han than in Tibetan children. The results of multivariate regression analysis showed that the lower age group (1–3 years old) was a protective factor for urinary vitamin C compared with the higher age group (4–6 years old) in Han children. However, the risk factors in Tibetan children were unclear. The reason for the analysis might be related to the eating habits of Han and Tibetan children. Tibetans prefer to eat beef, mutton, and dairy products, and have less intake of vegetables and fruits [22]. Han children started consuming complementary foods with increasing age. Also, the ingestion of a variety of vegetables and fruits gradually increased, resulting in the high detection rate of urine vitamin C in the higher age group. However, Tibetan children ingested less vegetables and fruits, leading to a low detection rate of vitamin C in the higher age group. This study also showed that a

passive smoking environment and parents' history of kidney disease were both risk factors. Also, smoking cessation restored the renal protective effect of ACEIs by reducing renal and oxidative stresses, suggesting that parents should pay attention to children's daily life and environmental health so as to prevent environmental damage to kidneys of children, especially children with a family history of kidney disease.

A positive detection rate of urinary ketone bodies is more common in diabetic ketoacidosis, nondiabetic ketosis, stress, exercise, fasting, infectious diseases, severe diarrhea, vomiting, and so in [23]. The present study found that the positive rate of ketone bodies was lower in Han children than in Tibetan children. The multivariate regression analysis showed that the positive rate of ketone bodies was higher in boys than in girls among Han children, and the detection rate of ketone bodies was higher in the higher age group (4–6 years old) than in the lower age group (1–3 years old) in Tibetan children. It might be due to more daily activities of Tibetan children compared with Han children, boys compared with girls, and the higher age group compared with the lower age group. These factors led to increased fat metabolism and relative insufficiency of carbohydrates, resulting in positive detection of ketone bodies. Among Tibetan children, "residence in newly renovated decorated houses" was a risk factor for the detection of urine ketone bodies. The decoration materials contain many harmful chemicals, and therefore it is suggested that parents should pay more attention to children's living environment.

## Conclusions

The differences in physiology, diet, and living environment of children in different ethnic groups may be fundamental influencing factors for urine abnormalities. Further, the susceptibility of girls' urinary system is worthy of attention. Hence, health education for children and their parents should be strengthened. Also, good hygiene habits, reasonable intake of nutrients, avoidance of lead-containing foods, and healthy living environment should be promoted. At the same time, children should be encouraged to actively participate in urine screening to prevent childhood kidney disease.

## Declarations

### Ethics approval and consent to participate

The present study was approved (approval no. gssdermyyyxllzfh201605) by the Ethics Committee in The Second People's Hospital of Gansu Province, China. The participation of children and their parents in the present study was voluntary. Written informed consent was obtained from a parent for participants under 16 years old.

### Consent for publication

Not applicable.

### Availability of data and materials

The datasets generated and analyzed during the current study are not publicly available due to the sensitive nature of the raw data; however, all relevant study datasets are available from the corresponding author on reasonable request.

### **Competing interests**

The authors declare that they have no actual or potential competing financial interests.

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### **Authors' contributions**

YF L, HB P, and PF designed the study and survey questionnaire, and HQ, JQ C conducted the survey, LM and XY Z conducted the data verification and initial analysis. HB P wrote the initial manuscript draft and was responsible for submission for publication. All authors have read and approved the final manuscript.

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## Tables

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