Article

Association between 24 h Urinary Sodium and Potassium Excretion and Dietary Intake in Japanese Male Adolescent Football Players

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Abstract: High urinary sodium-to-potassium ratio is considered a strong risk factor for hypertension. This study aimed to evaluate urinary excretion of sodium and potassium, and we analyzed these levels associated with dietary intake in Japanese adolescent football players. This cross-sectional study included 120 Japanese male adolescent football players. Over 24 h, urine was collected and measured for creatinine, sodium, and potassium levels. A dietary assessment was performed using a self-administered diet history questionnaire. The study analyzed 79 participants. The mean urinary sodium was 143.2 mmol/day, urinary potassium was 42.8 mmol/day, and the mean urinary sodium-to-potassium ratio was 3.6. Compared with the Japanese Dietary Reference Intakes, the estimated salt intake was 73.4% for the participants who exceeded the sodium intake, and the estimated potassium intake was 73.4% for the participants who did not satisfy it. Multiple regression analysis revealed that milk and dairy product intake was independently and positively associated with urinary potassium (β = 0.252) and independently and negatively associated with the urinary sodium-to-potassium ratio (β = −0.254). Adolescent football players had a high-sodium and low-potassium diet, well above the Japanese Dietary Reference Intakes recommendations. Milk and dairy products could be effective for increasing urinary potassium and decreasing the urinary sodium-to-potassium ratio.

Keywords: adolescent football players; cardiovascular diseases; urinary potassium; urinary sodium; urinary sodium-to-potassium ratio; dietary intake

1. Introduction

Cardiovascular diseases (CVDs) in adults are associated with hypertension, and high-sodium intake is a leading cause of hypertension [1]. Conversely, potassium attenuates sodium’s negative effects by increasing urinary sodium excretion [2]. Lower potassium intake is associated with elevated hypertension. Higher levels of consumption can prevent these conditions [3]. Increases in potassium intake reduce systolic blood pressure and the risk of developing CVDs [4,5]. On the other hand, the relationship between sodium and blood pressure strengthens if the urinary sodium-to-potassium (Na/K) ratio is considered instead of only sodium excretion rate [6]. Urinary Na/K ratio and blood pressure are reported to have a strong correlation [7]. In this regard, as a protective measure to prevent CVDs, it is crucial to determine the consumption patterns of low-sodium and high-potassium foods. The high-sodium and low-potassium diet consists of fish paste products and processed foods, and the high-potassium and low-sodium diet consists of milk and dairy products, fruits, and vegetables. Dairy products include cheese, yogurt, and ice cream [8].
Dietary habits established in youth greatly influence adult eating habits [9]. It was suggested by Shi et al. [10] that salt intake in childhood was associated with high blood pressure in later life [11]. Nonetheless, studies on the dietary habits of adolescents and children are limited. Okuda et al. [6] reported that the mean value of salt intake in 13-to 15-year-old Japanese adolescents was 10.6 ± 1.2 g/day for males (n = 24) and that in 98.2% of those participants, the level of salt intake exceeded the age-specific dietary goals recommended in the Japanese Dietary Reference Intakes (DRIs) [12].

A previous study showed that the dietary intake of highly physically active athletes was different from that of nonathletes [13]. Moreover, some reports [6,14] showed that energy intake and physical activity are associated with salt intake. Thus, adolescent athletes may consume too many nutrients when increasing food intake to meet their energy requirements [15]. We used a 3-day diet record and reported that adolescent football players (n = 59, mean age: 12.9 ± 2.6 years) exhibited an energy intake of 3020 ± 582 kcal and a salt intake of 12.6 ± 2.6 g. Salt intake in 84.7% of adolescent football players exceeded the Japanese DRIs [12,16]. However, researchers reported that amounts are underreported in evaluations of individual dietary records [17]. Dietary records are limited by reporting bias, so the best method to estimate sodium and potassium intake is to perform a 24 h urinary analysis [6,18]. To our knowledge, urinary excretion of sodium and potassium has not been investigated in young football players with high physical activity.

Understanding urinary excretion of sodium and potassium in adolescents, including athletes, is important for approaches toward child health issues. For these reasons, a need exists for a better understanding of the correlation between urinary markers and dietary intake in adolescent football players with the aim to prevent the development of hypertension by influencing dietary behaviors in childhood.

In the present study, we used 24 h urinary excretion to survey the sodium, potassium, and Na/K ratio among adolescent football players, and we analyzed these levels associated with dietary intake in adolescent football players.

2. Materials and Methods

2.1. Participants

The study design was a cross-sectional study. The present study was conducted in April 2017 at a football club in Saitama, Japan, and 120 healthy Japanese male adolescent football players (12–15 years) were recruited. The selection criteria were participants meet an advanced level of training according to the NSCA standards [19]. To meet the advanced level of training according to the NSCA, participants had to have a training age of ≥1 year, training frequency of ≥3–4 days per week, high degree of training stress, and high degree of technical experience and skill. Participants were not performing dietary management for weight increase or weight loss.

This study was approved by the Ethics Committee of Mukogawa Women’s University, Japan (No. 17–59). Each participant and guardian received written and verbal information about the study protocol before providing written informed consent. Written informed consent was obtained from each participant and their parents.

2.2. Twenty-Four-Hour Urine Collection

A single 24 h urine collection procedure was conducted to measure the 24 h urinary sodium and urinary potassium and urinary Na/K ratio based on World Health Organization (WHO)—cardiovascular diseases and Alimentary Comparison study methods [20]. Each participant received an aliquot cup and an instruction sheet on how to collect urine. Participants were instructed to discard the first-morning void and to collect all urine over the following 24 h period, including the first void on the next morning, and to record the collection time from start to finish.

The 24 h urine collections were not performed on days marked by sickness or vigorous sporting activity; urine collections were held during weekend practice or days without a match. After completing a 24 h urine collection, participants submitted their urine
samples at Musashigaoka Junior College. Next, the urine samples were measured and urine volume (mL/day) was calculated. Subsequently, the sample of urine was frozen at −20 °C and sent to Mukogawa Women’s University, Japan, to estimate the urinary sodium, potassium, and creatinine excretion. Urinary sodium (mmol/L) and potassium (mmol/L) levels were analyzed using an indirect ion-selective electrode method, and the urinary creatinine (mg/L) level was analyzed using the enzyme test. The amount of 24 h urinary sodium (mmol/day), urinary potassium (mmol/day), and creatinine excretion (mg/day) was calculated as urinary sodium (mmol/L), urinary potassium (mmol/L), and creatinine (mg/L) × urine volume (mL/day).

Completion of the 24 h urine collection was assessed by calculating the creatinine coefficient (CC), which is creatinine excretion (mg/day)/body mass in kg. A CC of 14.4 to 33.6 was considered an acceptable 24 h urine collection [21]. Sodium and potassium intakes were estimated by assuming that 86% and 77% of sodium and potassium, respectively, are excreted through urine [22,23]. Salt intake was estimated based on the calculation of 24 h urinary sodium if all sodium ingested was in the form of sodium chloride. Additionally, sodium intake in grams was calculated considering that 1 mmol of sodium was equal to 23 mg, and 1 g NaCl was equal to 393.4 mg of sodium [21]. Potassium intake in grams was estimated considering that 1 mmol of potassium was equal to 39.1 mg potassium [21]. The urinary Na/K ratio was also calculated as urinary sodium (mmol/day) divided by urinary potassium (mmol/day).

Estimated salt and potassium intake were compared with the Japanese DRIs. Then, we counted the participants who exceeded the salt intake and those who did not satisfy the Japanese DRIs for potassium. The Japanese DRIs [12] show that the age-specific dietary goal for salt intake (g/day) is <8.0 and potassium intake (mg/day) 2600 for those aged 13–15.

2.3. Dietary Assessment

Dietary intake was assessed using the self-administered diet history questionnaire (DHQ). Validity for food and nutrient intakes of the DHQ were published elsewhere [24,25]. The DHQ is a 22-page structured questionnaire comprising questions about the consumption frequency and portion size of selected foods commonly consumed in Japan, general dietary behaviors, and usual cooking methods [26]. In adolescent athletes, we verified the validity of DHQ using a 3-day dietary record (DR) and that the median correlation coefficient between DHQ and DR is 0.36 for 13 items of energy and nutrient and 0.30 for 13-items of food [16]. For that reason, although DHQ is limited to energy and some nutrients and foods, it is a useful questionnaire for assessing the dietary intake of adolescent athletes.

Like the previous study [16], we held a 60 min briefing session for the participants and their mothers to explain the portion size and the amount of school lunch in detail. We asked the participants and their mothers to answer the questions, and their mothers filled out the forms. Estimates of daily intakes of foods, energy, and nutrients were calculated using an ad hoc computer algorithm for the DHQ, which was based on the Standard Tables of Food Composition in Japan [27]. We excluded participants who reported an extremely unrealistic energy intake. Specifically, we excluded those whose reported energy intake was less than half the energy intake required for the lowest physical activity category or more than 1.5 times the energy intake required for the very high physical activity category [28]. As reported in a previous study, we used items with moderate or higher rank correlation [16], three items of nutrients (r = 0.46–0.55), and seven items of food (r = 0.31–0.53).

2.4. Other Variables

Body height was measured using a stadiometer (YHS-200D, YAGAMI Inc., Nagoya, Japan). Body mass and body fat percentage were measured using bioelectrical impedance analysis (InBody 470, Bio Space Inc., Seoul, Korea). Body height (to the nearest 0.1 cm), body mass (to the nearest 0.1 kg), and body fat percentage (to the nearest 0.1%) were measured while participants were wearing lightweight indoor clothes only, without shoes. Body mass index (kg/m²) was calculated as the body mass (body weight (kg)/body
height (m^2)). Fat-free mass was calculated as body mass (kg) − body mass (kg) × (body fat percentage (%)/100). The Fat-Free Mass Index was calculated as the fat-free mass (kg)/body height (m^2).

Age, school grade, and hours sports activities were self-reported. Physical activity was computed from three activities (vigorous activities, walking, and standing activities) using the DHQ.

The investigator measured blood pressure using an Omron HEM-757 automatic digital monitor (Omron Corp, Tokyo, Japan) after participants were allowed to sit for 5 min. Blood pressure was measured using a standardized, automated measurement system after the participants were allowed to sit for 5 min. The mean of two readings was used for analysis [21].

2.5. Statistical Analysis

All statistical analyses were performed using JMP version 14.3.0. Continuous variables are expressed as the mean ± standard deviation, and categorical variables are assessed as the counts and percentages. The normality of the data was performed using the Shapiro–Wilk test.

A multiple regression, with adjustment for potential confounding factors, was used to evaluate the association in urinary sodium, urinary potassium, and the urinary Na/K ratio with dietary intake. The dependent variables were urinary sodium, urinary potassium, and the urinary Na/K ratio, and the independent variable was dietary intake. The independent variable selection was calculated using a stepwise method. We presented unadjusted models (Model 1), a model adjusted for potential confounding factors (Model 2), and a model adjusted for all associated items in Model 2 (Model 3).

The potential confounding factors considered were, based on a previous reference [29], body weight and urinary potassium in urinary sodium, body weight and urinary sodium in urinary potassium, and body weight in the urinary Na/K ratio. All reported p values were two-tailed, and p values 0.05 were considered statistically significant.

3. Results

In the present study, 120 Japanese adolescent football players met the inclusion criteria, of which 119 (99.2%) provided written informed consent (Figure 1). In total, 40 participants were excluded from the analyses (6 missing data, 4 extremely unrealistic energy intake, 3 did not complete all urine collections, and 27 did not meet the CC criteria) [21]. Thus, data from 79 participants (65.8%) were analyzed.

Figure 1. Flowchart of the study participants.
Participant characteristics are listed in Table 1. The physical activity level was very high in 79.7% of the participants, and the cohort had the following mean values: age, 13.0 ± 0.8 years; duration of sports activities, 20.1 ± 3.5 h/week; body mass index, 18.4 ± 2.1 kg/m²; body fat percentage, 12.7 ± 4.1%; systolic blood pressure, 117.1 ± 12.6 mmHg; and diastolic blood pressure, 63.0 ± 8.3 mmHg.

Table 1. Basic characteristics of the study participants (mean values and standard deviations or number and percentages).

| Variable                           | All (n = 79) |
|------------------------------------|--------------|
|                                    | Mean | SD  |
| Age, years                         | 13.0 | 0.8 |
| School grade, n (%)                |      |     |
| Grade 7                            | 30 (38.0) |   |
| Grade 8                            | 28 (35.4) |   |
| Grade 9                            | 21 (26.6) |   |
| Physical activity level, n (%) a   |      |     |
| Level III (high)                   | 16 (20.3) |   |
| Level IV (very high)               | 63 (79.7) |   |
| Sports activities, h/week          | 20.1 | 3.5 |
| Systolic blood pressure, mmHg      | 117.1 | 12.6 |
| Diastolic blood pressure, mmHg     | 63.0 | 8.3  |
| Body height, cm                    | 157.2 | 9.8 |
| Body mass, kg                      | 45.7 | 9.0 |
| BMI, kg/m²                         | 18.4 | 2.1 |
| Body fat percentage, %             | 12.7 | 4.1 |
| Fat-free mass, kg                  | 37.2 | 6.6 |
| FFMI, kg/m²                        | 14.9 | 1.1 |

BMI: body mass index; DHQ: diet history questionnaire; FFMI: Fat-Free Mass Index; SD: standard deviation; a physical activity level was calculated using the DHQ.

Urinary data on sodium and potassium excretion are in Table 2. The mean urinary sodium was 143.2 ± 44.7 mmol/day; the mean urinary potassium was 42.8 ± 14.2 mmol/day. The mean urinary Na/K ratio was 3.6 ± 1.2 the molar ratio.

Table 2. Urinary data on sodium and potassium excretion.

| Variable                           | All (n = 79) |
|------------------------------------|--------------|
|                                    | Mean | SD  |
| Sodium, mmol/L                     | 170.8 | 35.1 |
| Sodium, mmol/day                   | 143.2 | 44.7 |
| Potassium, mmol/L                  | 51.8  | 14.7 |
| Potassium, mmol/day                | 42.8  | 14.2 |
| Na/K ratio, molar ratio            | 3.6   | 1.2 |
| Volume output, mL/day              | 857.1 | 214.4 |
| Creatinine excretion, mg/L         | 132.6 | 37.4 |

Na/K ratio, sodium-to-potassium ratio; SD, standard deviation.

The dietary intake and estimated dietary intake of the study participants are listed in Table 3. The mean energy intake was 3194 ± 717 kcal/day, the mean estimated salt intake was 9.7 ± 3.0 g/day, and 73.4% of the participants exceeded the Japanese DRIs for the 12- to 14-year-old age group. The mean estimated potassium intake was 2172 ± 719 mg/day, and 73.4% of the participants did not satisfy the Japanese DRIs for the 12- to 14-year-old age group.
Table 3. Dietary intake and estimated dietary intake of the study participants.

| Variable                                      | All (n = 79) |
|-----------------------------------------------|--------------|
|                                              | Mean | SD |
| Dietary intake                               |      |    |
| Energy, kcal/day                              | 3194 | 717|
| Protein, g/day                                | 104.4| 26.9|
| Protein, g/kg BM                              | 2.4  | 0.7 |
| Protein, % of energy                          | 13.1 | 1.7 |
| Fat, g/day                                    | 95.6 | 26.6|
| Fat, g/kg BM                                  | 2.2  | 0.7 |
| Fat, % of energy                              | 27.1 | 5.3 |
| Carbohydrate, g/day                           | 464.8| 124.4|
| Carbohydrate, g/kg BM                         | 10.4 | 3.0 |
| Carbohydrate, % of energy                     | 58.0 | 6.4 |
| Grains, g/day                                 | 833.8| 269.8|
| Potatoes, g/day                               | 34.4 | 22.5|
| Vegetables, g/day                             | 304.6| 194.5|
| Fruit, g/day                                  | 170.6| 149.3|
| Fishes and shellfishes, g/day                 | 67.7 | 45.6|
| Milk and dairy products, g/day                | 364.2| 204.9|
| Seasoning, g/day                              | 20.6 | 20.6|
| Estimated dietary intake                      |      |    |
| Salt intake a                                 | 9.7  | 3.0 |
| Salt intake exceed 8.0 g/day, n (%) a,b       | 58 (73.4)| 58 (73.4)|
| Potassium intake a                            | 2172 | 719 |

BM, body mass; SD, standard deviation; a salt and potassium intakes were estimated by assuming that 86 and 77% of each nutrient, respectively, is excreted through urine; b estimated salt and potassium intakes were compared to the Japanese Dietary Reference Intakes [12].

Multiple regression models of urinary sodium, urinary potassium, and the urinary Na/K ratio are in Table 4. Urinary potassium was positively associated with fruit and milk and dairy products in single-regression analysis (Model 1). These variables, additional adjustments for body mass and urinary sodium, and their associations were evaluated (Model 2). Furthermore, all these variables were input as independent variables, and only milk and dairy products remained (Model 3). The urinary Na/K ratio was positively associated with carbohydrates and negatively associated with fruit, vegetables, and milk and dairy products in the single-regression analysis (Model 1). These variables were included in the model, with additional adjustments made for body mass. Fruit, vegetables, and milk and dairy products remained in the model (Model 2). Furthermore, the inputs for all these variables were included as independent variables, and only milk and dairy products remained (Model 3).
Table 4. Multiple regression model of urinary sodium, urinary potassium, and urinary Na/K ratio.

|                | Urinary Sodium | Urinary Potassium | Urinary Na/K Ratio |
|----------------|----------------|-------------------|--------------------|
|                | Model 1        | Model 1           | Model 2            | Model 3            | Model 1 | Model 2 | Model 3 |
|                | β              | p                | β                  | p                | β      | p      | β      |
| Protein        | 0.209          | 0.065            | 0.034              | 0.766            | -      | -      | -      |
| Fat            | 0.097          | 0.396            | 0.093              | 0.416            | -      | -      | -      |
| Carbohydrate   | 0.038          | 0.739            | 0.143              | 0.210            | -      | -      | -      |
| Grains         | 0.078          | 0.495            | 0.076              | 0.504            | -      | -      | -      |
| Potatoes       | 0.110          | 0.336            | 0.014              | 0.903            | -      | -      | -      |
| Vegetables     | 0.009          | 0.936            | 0.230              | 0.041            | 0.224  | 0.039  | 0.140  | 0.195  | -      | -      |
| Fruit          | 0.029          | 0.797            | 0.161              | 0.156            | -      | -      | -      |
| Fishes and shellfishes | 0.133 | 0.241 | -0.102 | 0.369 | - | - | - | - | - |
| Milk and dairy products | 0.007 | 0.953 | 0.304 | 0.007 | 0.303 | 0.005 | 0.252 | 0.021 | -0.317 | 0.004 | -0.298 | 0.008 | -0.254 | 0.026 |
| Seasoning      | -0.051         | 0.658            | 0.051              | 0.656            | -      | -      | -      |

β, standardized regression coefficient; Na/K, sodium-to-potassium ratio; a multiple regression, with adjustment for potential confounding factors, was used to evaluate the association in urinary sodium, urinary potassium, and the urinary Na/K ratio with dietary intake; the dependent variables were urinary sodium, urinary potassium, and the urinary Na/K ratio, and the independent variable was dietary intake; the independent variable selection was calculated using a stepwise method; Model 1: unadjusted model; Model 2: a model adjusted for potential confounding factors; Model 3: a model adjusted for all associated items in Model 2; a the potential confounding factors were body mass and urinary sodium; b the potential confounding factors was body mass.

4. Discussion

The aim of the present study was to use 24 h urinary excretion values to assess sodium and potassium excretion and the urinary sodium/potassium ratio among adolescent football players. The association between 24 h sodium and potassium excretion and dietary intake was also evaluated. We found that the mean urinary excretion was 143.2 mmol/day in adolescent football players and that the estimated salt intake exceeded the Japanese DRIs in 73.4% of the participants [12].

Data on sodium excretion in Japanese adolescent football players are scarce, but sodium excretion in our cohort was similar to that reported by Okuda et al. [6], i.e., 181 mmol/day of 12–15-year-old Japanese adolescents (n = 24). On the other hand, comparing our results to other adolescents, Japanese adolescent football players seem to have a mean sodium excretion greater than that of Italian (129 mmol/day) [30] and German (131 mmol/day) adolescents [10]. Compared to those references, the urinary sodium in adolescent football players in this study was high.

Potassium excretion in our cohort was 42.8 mmol/day, and even though 73.4% of the participants did not satisfy the Japanese DRIs for estimated potassium intake [12], our values are comparable to those reported by others (43.4 mmol/day) in Japanese adolescents [6]. In contrast, compared with adolescent populations in other countries, the mean potassium excretion in our cohort was lower, e.g., Portugal (57 mmol/day) [31] or Australia (54 mmol/day) [8]. The urinary potassium level in adolescent football players in this study was low, similar to that in Japanese adolescents.

The mean urinary Na/K molar ratio was 3.6 in this study; this is well above the recommended value of 1.5, which is considered beneficial for health by the WHO [32,33].

Our study’s participants showed higher values than those reported previously in Portugal (1.7) [31] and Australia (2.4) [8]. Thus, our results imply that poor dietary behavior during early childhood in Japanese adolescent football players was seen with a high urinary Na/K ratio (about 2.5-times greater than 1 molar ratio).

In our study, milk and dairy products showed an independent association with urinary potassium. Association between milk and dairy products and the urinary Na/K ratio is depicted in Figure 2. According to previous studies identifying major sources of potassium, Grimes et al. [8] reported that the major sources of potassium were milk and dairy products (11.5%) in Australian adolescents. Carla et al. [31] reported that, for potassium intake, the main sources were milk and milk products (21%) in Portuguese adolescents. Ballew et al. [34] reported that the single most substantial dietary source of potassium was milk and dairy products (22%) among children and adolescents in the United States. Thus, the results of the present study support previous studies that potassium intake is associated with milk and dairy products [8,31]. On the other hand,
our results were different from Okuda et al. [6], who reported that the urinary Na/K ratio was associated with the intake of fruits in Japanese adolescents. Our results may reflect the low proportion of adolescent football players who follow the recommendation to eat at least 350 g vegetables and 200 g fruit and daily (32% and 33%, respectively; data not shown) [35].

Figure 2. Association between milk and dairy products and the urinary sodium-to-potassium ratio.

As a characteristic eating habit, Japanese have a high intake of vegetables and seafood, but their salt intake is also high. Salt content is high in traditional Japanese foods, such as soy sauce, miso soup, and Japanese pickles. On the other hand, the consumption of milk and dairy products is very low when compared to that in Western countries. Therefore, the amount of calcium in Japanese cuisine does not meet the recommended amount by the Japanese DRIs [12]. One of the problems of adolescents in Japan is the inadequate intake of nutrients caused by shortened sleep hours and skipping breakfasts. Japanese dietary guidelines strongly recommend the daily consumption of breakfast [36].

Milk and dairy products are often consumed at breakfast, while milk and dairy products form the most basic nutritious foods with the closest affinity to perfect food, they are a rich source of essential nutrients such as high-quality proteins, calcium, potassium, and vitamin D. Conversely, milk and dairy products play an important role in childhood growth and development. Food processing reduces the natural amount of potassium in many food products [37]. Milk and dairy products are usually consumed without cooking; hence, a high level of milk and dairy product intake is an effective way to increase potassium intake [38]. However, based on the national survey data, milk consumption has decreased over time in developed countries. In Japan, during 1995–2015, per capita, milk consumption has decreased from 144 g to 132 g [39,40]. Since adolescent football players need to satisfy their energy and nutrient requirements, it is difficult for them to reduce the amount of dietary salt intake. In our study, milk and dairy products seem to show potential for improving urinary potassium and the urinary Na/K ratio if their consumption could be stimulated in adolescent football players. Therefore, nutrition education should be provided to adolescent football players to encourage the consumption of milk and dairy products.

The strengths of the present study include the use of 24 h urinary samples for urinary sodium and urinary potassium and the use of dietary intake calculation using a validated questionnaire, measuring the anthropometric data of adolescent football players.

This study has a few limitations. First, the cross-sectional nature of the study did not permit the assessment of causality owing to the uncertain temporality of the association. Second, some selection bias may have occurred in selecting the participants because the
research was only conducted on male football players from a single football team. There were only 79 participants in this study, which indicates a small sample size, highlighting the need for a larger sample size that also includes female football players in the future. In addition, most of the data are comparable with those of the Japanese DRIs in this study, suggesting a possible systematic error in our study. In the future, the relevant values of ordinary teenagers from the same age group must be measured simultaneously for comparison with athletes. Moreover, 24 h urine sampling is difficult for some population groups, such as very young children [41]. Although we made every effort to enable and support the children and their parents in collecting complete samples in this study, in some cases, the 24 h urine collection could not be performed. Furthermore, the 24 h urinary collection was only performed once. A single 24 h urine collection may cause difficulty in establishing common excretion levels, in addition to the possible influence of season on excreted potassium and sodium in the urine. A recent study has reported that individual day-to-day variability in urinary sodium is large, implying that a 24 h urine collection may not accurately estimate dietary salt intake at the individual level [42], and Peniamina et al. [43] have reported that 24 h urinary potassium may not be an accurate method for estimating potassium intake. However, while the collection of multiple consecutive 24 h urines increases accuracy, it also increases the subject burden. Charlton et al. [44] reported that 24 h sodium excretion measured in a single 24 h urine collection is sufficient for the estimation of short-term average population intake. Our study supports the WHO and other current recommendations with respect to measuring population-level urinary potassium levels in children using 24 h urine samples. Estimates of sodium and potassium intake are recommended for monitoring the effectiveness of current actions to reduce sodium intake and to improve efforts to increase potassium consumption in adolescents [31]. Third, the effects of physical activity and sodium loss due to sweating could not be completely excluded even though urine collections were held during weekend practice or when matches were not scheduled (to avoid the effects of physical activity). Further, temperatures may have been higher in the Saitama prefecture, even in spring, and a greater-than-anticipated proportion of sodium could have been lost in sweat. Previous studies have stated that, depending on climate and amount of physical activity, as much as 33–57% of sodium consumed could be lost in sweat [45], and it has been reported that male athletes in the National Collegiate Athletic Association Division I consumed 2.9 ± 1.3 g/day of salt [46]. Thus, urinary sodium and potassium in our study may have been underestimated. Finally, the dietary assessment was conducted using a dietary assessment questionnaire (i.e., DHQ), and sodium consumed as a sports supplement, or a drink, represents a residual confounding factor that may change the association observed in this study.

5. Conclusions

We found that Japanese adolescent football players have high urinary sodium and low urinary potassium and high urinary Na/K ratio. Our study suggested that Japanese adolescent football players have poor dietary habits that begin in early childhood. Milk and dairy products were independently associated with urinary potassium and the urinary Na/K ratio. Thus, milk and dairy products could be effective for increasing urinary potassium and decreasing the urinary Na/K ratio. Nutrition education should be provided to adolescent football players to encourage the consumption of milk and dairy products.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available as they contain private information of the participants.

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