Original Contribution

Body Size, Dairy Consumption, Puberty, and Risk of Testicular Germ Cell Tumors

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The etiology of testicular germ cell tumors (TGCTs) is poorly understood, with cryptorchidism and family history being the only well-established risk factors. Body size, age at puberty, and dairy consumption, however, have been suggested to be related to TGCTs. To clarify the relation of these variables to TGCT risk and to one another, the authors analyzed data from 767 cases and 928 controls enrolled in the Servicemen’s Testicular Tumor Environmental and Endocrine Determinants Study (2002–2005). Overall, increased height was significantly related to risk (odds ratio (OR) = 1.83, 95% confidence interval (CI): 1.36, 2.45), though body mass index was not (OR = 1.06, 95% CI: 0.66, 1.69). There was no association with age at puberty, based on ages at first shaving (OR = 1.29, 95% CI: 0.96, 1.73), voice changing (OR = 0.97, 95% CI: 0.71, 1.32), and nocturnal emissions (OR = 1.00, 95% CI: 0.73, 1.37). Similarly, there was no relation with dairy consumption at any age between birth and 12th grade. These results suggest that height is a risk factor for TGCTs, but the relation is unlikely explained by childhood dairy consumption. As adult height is largely determined in the first 2 years of life, increased attention to events in this interval may help elucidate the etiology of TGCTs.

body height; diet; puberty; testicular neoplasms

Abbreviations: CI, confidence interval; DoDSR, Department of Defense Serum Repository; OR, odds ratio; SD, standard deviation; TGCT, testicular germ cell tumor.

Testicular germ cell tumors (TGCTs) are the most common cancer among US men aged 15–35 years (1). Nevertheless, the only well-documented risk factors are cryptorchidism, prior history of TGCT, and family history of TGCT (2). Evidence suggests, however, that TGCT risk is determined very early in life, possibly even in utero (3).

One possible risk factor that has received increasing attention is body size. Weight, height, and body mass index (weight (kg)/height (m)²) have been examined in a number of studies, with mixed results (4–16). Although few studies have reported significant associations with body mass index and risk (4, 8, 9), most have found associations with increased height (4, 6, 7, 10, 11). One explanation for the height association may be that better childhood nutrition increases both adult height and risk of TGCT (10). This hypothesis is supported by observations that TGCT risk

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tends to be higher in economically advantaged countries (17) and is associated with higher socioeconomic status (2). Which particular nutrients might be implicated is less clear, although several studies have reported positive associations between dairy intake and TGCT risk (8, 18, 19). Whether childhood dairy intake is responsible for an association between height and TGCT, however, has not been previously reported.

Another possible risk factor for TGCT is age at puberty, as several studies have reported that later age is protective (20–23). In that height, age at puberty, and childhood nutrition tend to be related to one another (24) and possibly to TGCT, all three variables were examined in the current study.

MATERIALS AND METHODS

Study population

The US Servicemen’s Testicular Tumor Environmental and Endocrine Determinants (STEED) Study enrolled participants between April 2002 and January 2005. To be eligible for the study, servicemen had to have at least one serum sample stored in the Department of Defense Serum Repository (DoDSR, Silver Spring, Maryland) and to be no older than 45 years of age. The DoDSR began storing serum samples from military personnel in 1985. The Repository now includes roughly 40 million samples, with approximately 2.3 million added each year. By use of a person-specific identifier, the specimens in the DoDSR computerized database were linked to the Defense Medical Surveillance System (DMSS) (25) and to other military medical databases in order to determine which military personnel had developed medical conditions.

For the Servicemen’s Testicular Tumor Environmental and Endocrine Determinants Study, all men with a sample in the DoDSR who subsequently developed TGCT while on active duty were eligible to participate as cases. Men with a sample in the DoDSR who did not subsequently develop TGCT were eligible to participate as controls. Diagnoses of TGCT were limited to classic seminoma or nonseminoma (embryonal carcinoma, yolk sac carcinoma, choriocarcinoma, teratomas, mixed germ cell tumor), as spermatocytic seminoma occurs primarily among older men and is thought to have an etiology distinct from other TGCTs. The diagnoses were based on the original pathology reports or on review (6.5 percent) of the pathology slides.

The study was designed as a pair-matched, case-control study, although additional controls were initially identified because of the transient nature of the military population. By use of the computerized Defense Medical Surveillance System database, all available controls were identified for each potential case participant. From the list of possible controls, four individuals who matched each case on age (within 1 year), race (White, Black, other), and date of available serum sample (within 30 days) were chosen at random as the control set. The first man on the list was designated as the primary control. Every attempt was made to enroll this man for 30 days (average number of attempted contacts = 90). The effort included tracing attempts, multiple letters, and telephone calls. If the man could not be traced, was deployed to a combat zone, was deceased, refused to participate, or could not be contacted within a 30-day period, attempts were begun to enroll the next possible control in the set.

The database linkage identified 961 cases who appeared to meet the study criteria. Further review found that 76 men could not be traced, 27 had died, three were known to be deployed to a combat zone, and two were found ineligible, leaving 853 possible participants. Of these men, 22 were in the process of being contacted when the study closed. Thus, of the 831 men contacted, 754 agreed to participate, resulting in a participation rate of 91 percent. In the instances where the potential case was deceased, the study attempted to obtain proxy information from the man’s mother. Thirteen proxy questionnaires were completed by the mothers of the 27 deceased men. Among the controls, 2,579 were evaluated for inclusion. Of these men, 385 men could not be traced, 18 had died, 64 were known to be deployed to a combat zone, and two were found ineligible. In addition, 928 could not be contacted within 30 days. Of the remaining 1,182 men, 32 were in the process of being contacted when the study closed. Thus, of the 1,150 men contacted, 928 agreed to participate, resulting in a participation rate of 81 percent. Among the 754 cases and 928 controls, there were 720 matched case-control pairs.

In order to participate in the study, each man was asked to complete a study questionnaire, to donate a buccal cell sample collected in mouthwash, to grant permission to use his DoDSR specimen, and to sign an informed consent document. In addition, each participant was asked for permission to contact his mother in order to enroll her in the study. The study was approved by the institutional review boards of the National Cancer Institute, Bethesda, Maryland, and the Walter Reed Army Institute for Research, Silver Spring, Maryland.

Questionnaire data

Each participant was administered a computer-assisted telephone interview composed of nine modules. Cases were asked questions in reference to a date 1 year prior to their TGCT diagnosis (referred to as the “reference date”). Controls were assigned the same reference date as their matched case. For the current analysis, participants were asked to report their height and weight as of the reference date. For the questions on dairy consumption, participants were asked whether they drank milk or ate dairy products (not including eggs or soymilk) at least 3 times a week during the time interval of interest and at least three times a week at any point in their lives between birth and 12th grade. The time intervals were chosen to correspond with ages in various schools (through kindergarten, elementary school, middle school/junior high school, high school) as a stimulus to memory. The question on lactose intolerance asked whether the participant had ever been told by a doctor that he was lactose intolerant. The questions on puberty asked the participant to report his age in years at which 1) he began to shave, 2) he began to have nocturnal emissions (i.e., “wet dreams”), and 3) his voice began to change.

Measured body size data

As self-reported body size data can be biased, measured height and weight at the time of military enrollment were obtained for approximately one quarter of the participants. The measured height data were contrasted with the self-reported height data to determine whether the two values were correlated and to determine whether there was preferential bias in reporting by case-control status.

Statistical analysis

Odds ratios and 95 percent confidence intervals were calculated to estimate the association of the variables of interest with risk of TGCTs. Given the matched case-control design, risk estimates adjusting for confounders were first generated by use of conditional logistic regression, restricting the analysis to only the 720 matched sets. Modeling using unconditional logistic regression was subsequently performed utilizing the data from all participants. As this involved breaking the match, risk estimates derived from the unconditional logistic regression models were first minimally adjusted, taking into account only the three matching factors: age at reference date, race, and date of serum sample collection. Further adjustment (in the fully adjusted model) was then made for the known TGCT risk factors: history of cryptorchidism and family history of testicular cancer. When applicable, tests for linear trend in risk according to the ordinal scale of a given variable were conducted to evaluate possible dose-response relations. In addition, stratified analyses by tumor histology were performed to assess whether risks of seminoma and nonseminoma differed in relation to each exposure of interest. One case was excluded from these analyses, because the tumor histology was unknown. As results using conditional and unconditional logistic regression were similar, only those using the latter approach are presented. Statistical analyses were conducted with SAS, release 8.2, software (SAS Institute, Inc., Cary, North Carolina). All tests were two sided, with \( p < 0.05 \) defined as statistically significant.

RESULTS

The distributions of demographic variables in the study population are displayed in table 1. As cases and controls were matched on age and race, there were no differences in the overall distributions of these variables. The ages of the seminoma cases versus controls and nonseminoma cases versus controls appear to differ, because the cases are being compared with all controls. As anticipated, the mean age of the nonseminoma cases (26.0 years; standard deviation (SD): 5.4) was lower than the mean age of the seminoma cases (30.3 years; SD: 5.9). Approximately 85 percent of the study population were White, 4 percent were Black, and 11 percent were members of other racial/ethnic groups. Cases were more likely than controls to have a history of cryptorchidism (\( p < 0.0001 \)) and to have a family history of testicular cancer (\( p < 0.0005 \)).

The relations of anthropometric variables and TGCT risk are shown in table 2. Comparing quartile 4 with quartile 1 in minimally adjusted analysis, we found that cases were significantly heavier (odds ratio (OR) = 1.39, 95 percent confidence interval (CI): 1.06, 1.83) and taller (OR = 1.88, 95 percent CI: 1.40, 2.51) than the controls. There was no relation, however, between body mass index and TGCT risk (OR = 1.06, 95 percent CI: 0.67, 1.68). In the fully adjusted analysis, weight was no longer associated with risk (OR = 1.13, 95 percent CI: 0.83, 1.54), but the relation between height and risk was essentially unchanged (OR = 1.83, 95 percent CI: 1.36, 2.45). Height was equally related to risk of both seminoma and nonseminoma. As in the minimally adjusted analysis, body mass index was not related to risk of TGCTs (OR = 1.06, 95 percent CI: 0.66, 1.69).

The relation between childhood dairy consumption and TGCT risk is shown in table 3. There were no differences between the minimally adjusted and the fully adjusted results. Dairy consumption was unrelated to risk at any age between birth and high school. Risk was also unrelated to being lactose intolerant. Cases, however, were significantly more likely than controls to consume 2 percent milk (OR = 1.53, 95 percent CI: 1.11, 2.10), and the relation was evident among seminoma cases (OR = 1.56, 95 percent CI: 1.00, 2.43) and nonseminoma cases (OR = 1.50, 95 percent CI: 1.04, 2.17).

The relations between indicators of age at puberty and TGCT risk are shown in table 4. Again, there were no differences in results between the minimally adjusted and the fully adjusted models. Neither the age at first nocturnal emissions nor the age at which the voice changed was related to risk. The age at first shaving was related to increased risk only among the nonseminoma cases. The nonseminoma cases were more likely to start shaving at older ages (>17 years) than were the controls (OR = 1.48, 95 percent CI: 1.05, 2.10; \( p_{trend} = 0.04 \)).

In order to determine whether the risk variables were associated with one another, we examined correlations of the variables. The relations between height and dairy consumption (\( r = -0.08, p = 0.11 \)) and between height and age at puberty (\( r = 0.02, p = 0.26 \)) indicated that there was little correlation in the variables.

To examine whether there was a difference in the accuracy with which cases and controls reported their weight, we compared measured height (at the time of military enlistment) with self-reported height among 394 men (184 cases, 210 controls); \( t \) tests of the difference between self-reported and measured height found no significant differences between the cases and the controls (\( p = 0.23 \)). Overall, the Pearson correlation between self-reported and measured height was 0.63 (\( p < 0.0001 \)). The cases were more accurate in their reporting, however, as the Pearson correlation for the cases was 0.91 (\( p < 0.0001 \)), while it was 0.53 (\( p < 0.0001 \)) for the controls. Both cases and controls tended to overstate their heights by an average of 2.73 cm (SD: 8.06). The controls did so, however, to a somewhat greater extent than the cases. The actual difference between the self-reported and measured heights in the controls was 3.18 cm (SD: 9.7) versus 2.22 cm (SD: 2.6) in the cases, suggesting that there was a greater difference in case-control height than was captured in the self-reported data. The difference between measured and self-reported weights was not examined, as...
the data were drawn from different points in the participants’ lives.

DISCUSSION

The incidence of TGCTs has been increasing in men of Northern European ancestry since World War II (26). Although the risk factors driving the increase are unknown, it is clear that the risk is consistent with a birth cohort phenomenon (3, 26, 27), as each cohort since the mid-1940s has had a higher risk of TGCT than the previous cohort. A birth cohort effect suggests that the increase in incidence is related to changing prevalence of one or more risk factors in the population (1). As evidence also suggests that the risk of TGCT may be determined early in life, a putative TGCT risk factor would likely be acting at this stage of development. Some suggested early life risk factors include environmental endocrine modulators (28), maternal smoking (29), maternal body size (30), and nutrition (18).

Body size is, in part, a reflection of nutrition, with weight reflecting dietary intake throughout life and height reflecting intake at early ages. If early life nutrition is related to the risk of TGCTs, it is conceivable that the relation would be manifested as a height effect. Conversely, if nutrition throughout life is related to risk, it would be more likely to see a relation with body mass index. A number of studies have now examined the associations between body mass index and/or height and TGCTs. Although two studies found an inverse relation with body mass index (4, 9) and one study found a positive relation (8), most studies have reported no association (5–7, 10, 11, 13, 14, 16, 22). Height, in contrast, has been positively associated with risk in the majority of studies in which it has been examined. Of at least 12 studies reported in the English language literature, six, including the present study, reported significant positive associations (4, 6, 7, 10, 11). An additional two studies reported nonsignificant positive associations (21, 22), while four studies reported no association (5, 9, 14, 16). Overall, the bulk of the evidence suggests that body mass index is not associated with risk, but increased height is associated.

Adult height is known to be associated with a number of factors, including size at birth, diseases in childhood, and childhood nutrition (31). Whether the association with height and risk can be explained by childhood nutrition, however, is not clear as studies of nutrition at any age and TGCTs have been few. Davies et al. (18) examined dietary intake at age 17 years and reported a significant association with the consumption of milk, but not with other dairy products. The association with milk was supported by an ecologic study that correlated testicular cancer rates with food consumption 30 years prior to cancer diagnosis (19). The strongest correlation in the study, however, was with cheese consumption rather than milk. Garner et al. (8) also reported an association between cheese consumption and risk, but the study examined dietary intake only as an adult. Three other diet studies reported no association between milk and/or

| TABLE 1. Characteristics of study participants, STEED Study, 2002–2005 |
|------------------------|------------------------|------------------------|------------------------|------------------------|
| Variable               | Controls              | All TGCTs              | Seminoma               | Nonseminoma            |
|                       | (n = 928)             | (n = 767)              | (n = 324)              | (n = 442)              |
| Age (years)           |                       |                       |                       |                       |
| <25                   | 318 34.3              | 278 36.2              | 61 18.8                | 216 48.9              |
| 25–29                 | 277 29.9              | 217 28.3              | 97 29.9                | 120 27.1              |
| 30–34                 | 174 18.7              | 137 17.9              | 78 24.1                | 59 13.3               |
| 35–39                 | 120 12.9              | 101 13.2              | 64 19.8                | 37 8.4                |
| ≥40                   | 39 4.2                | 34 4.4                | 24 7.4                | <0.0001 10 2.3       |
| Race                  |                       |                       |                       |                       |
| White                 | 788 84.9              | 647 84.6              | 260 80.2              | 387 87.5              |
| Black                 | 35 3.8                | 22 3.3                | 12 3.7                | 10 2.3                |
| Other                 | 105 11.3              | 98 12.1              | 52 16.1              | 45 10.2              |
| Cryptorchidism        |                       |                       |                       |                       |
| No                    | 912 98.3              | 726 94.7              | 313 96.6              | 412 93.2              |
| Yes                   | 16 1.7                | 41 5.3                | 11 3.4                | 30 6.8       <0.0001 |
| Family history of testicular cancer† | |                       |                       |                       |
| No                    | 914 98.5              | 734 95.7              | 307 94.8              | 426 96.4              |
| Yes                   | 14 1.5                | 33 4.3                | 17 5.2                | 16 3.6                |

* STEED, Servicemen’s Testicular Tumor Environmental and Endocrine Determinants; TGCT, testicular germ cell tumor.
† Based on chi-square tests.
‡ Family history among first- and second-degree relatives.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Controls</th>
<th>All TGCT*</th>
<th>Seminoma</th>
<th>Nonseminoma</th>
</tr>
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<tr>
<td></td>
<td>No. %</td>
<td>No. %</td>
<td>Odds ratio†</td>
<td>Odds ratio‡</td>
</tr>
<tr>
<td>Reference weight (kg)§</td>
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<td></td>
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<td>≤72.58</td>
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<td>28.0</td>
<td>198</td>
<td>26.0</td>
</tr>
<tr>
<td>72.59–79.38</td>
<td>209</td>
<td>22.5</td>
<td>168</td>
<td>22.0</td>
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<td>79.39–86.18</td>
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<td>28.0</td>
<td>188</td>
<td>24.6</td>
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<td>&gt;86.18</td>
<td>199</td>
<td>21.4</td>
<td>209</td>
<td>27.4</td>
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<td></td>
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<td>Reference height (cm)¶</td>
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<td>157</td>
<td>20.5</td>
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<td>197</td>
<td>25.8</td>
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<tr>
<td>&gt;182.88</td>
<td>171</td>
<td>18.4</td>
<td>188</td>
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<tr>
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<td>Body mass index (kg/m²)</td>
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<td>10</td>
<td>1.3</td>
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<td>≥30</td>
<td>47</td>
<td>5.1</td>
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* STEED, Servicemen’s Testicular Tumor Environmental and Endocrine Determinants; TGCT, testicular germ cell tumor.
† Logistic regression adjusted for matching factors (reference age, race, and serum date).
‡ Logistic regression adjusted for matching factors, cryptorchidism, and family history of testicular cancer.
§ Missing data for four cases; categorized according to quartile distribution among controls.
¶ Missing data for two cases; categorized according to quartile distribution among controls.
TABLE 3. Relation of dairy consumption at various ages to testicular germ cell tumors by histology, STEED* Study, 2002–2005

<table>
<thead>
<tr>
<th>Variable</th>
<th>Controls</th>
<th>TGCT*</th>
<th>Seminoma</th>
<th>Nonseminoma</th>
</tr>
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<td></td>
<td>No. %</td>
<td>Odds ratio†</td>
<td>Odds ratio‡</td>
<td>No. %</td>
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<td></td>
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<td>(95% confidence interval)</td>
<td>(95% confidence interval)</td>
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<td>Dairy consumption, any age§</td>
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<td>Yes</td>
<td>910 98.1</td>
<td>755 98.8</td>
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<td>Referent</td>
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<td>No</td>
<td>18 1.9</td>
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<td>0.61 0.64</td>
<td>0.29 1.45</td>
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<td>896 97.5</td>
<td>735 97.7</td>
<td>1.00 1.00</td>
<td>Referent</td>
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<td>No</td>
<td>23 2.5</td>
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<td>0.90 0.92</td>
<td>0.49 1.76</td>
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<td>Dairy consumption, grades 1–5#</td>
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<td>751 98.4</td>
<td>1.00 1.00</td>
<td>Referent</td>
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<td>0.69 0.73</td>
<td>0.35 1.50</td>
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<td>Dairy consumption, grades 6–8**</td>
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<td>899 97.2</td>
<td>751 98.6</td>
<td>1.00 1.00</td>
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<td>0.26 1.09</td>
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<td>742 97.1</td>
<td>1.00 1.00</td>
<td>Referent</td>
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<tr>
<td>Yes</td>
<td>20 2.2</td>
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<td>1.35 1.33</td>
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<td>Type of milk consumed most</td>
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<td>394 75.6</td>
<td>1.00 1.00</td>
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<td>13 2.5</td>
<td>1.55 1.51</td>
<td>0.65 3.51</td>
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* STEED, Servicemen’s Testicular Tumor Environmental and Endocrine Determinants; TGCT, testicular germ cell tumor.
† Logistic regression adjusted for matching factors (reference age, race, and serum date).
‡ Logistic regression adjusted for matching factors, cryptorchidism, and family history of testicular cancer.
§ Excludes individuals with data missing (three cases).
¶ Excludes individuals with data missing (three cases) or unknown (12 cases, nine controls).
# Excludes individuals with data missing (three cases) or unknown (one case, two controls).
** Excludes individuals with data missing (three cases) or unknown (12 cases, nine controls).
†† Excludes individuals with data missing (three cases) or unknown (two cases, three controls).
‡‡ Excludes individuals with data missing (two cases) or unknown (one case, one control).
### TABLE 4. Relation of age at pubertal events to testicular germ cell tumors by histology, STEED Study, 2002–2005

<table>
<thead>
<tr>
<th>Variable</th>
<th>Controls</th>
<th>Testicular cancer</th>
<th>Seminoma</th>
<th>Nonseminoma</th>
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<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Age at first nocturnal emissions (years)</td>
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<td>32.9</td>
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<td>13–14</td>
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<td>107</td>
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<td>86</td>
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<td>&gt;15</td>
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<td>16.9</td>
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<td>Age when voice first changed (years)</td>
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<tr>
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<td>335</td>
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<td>25.5</td>
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<td>23.8</td>
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<td>109</td>
<td>12.6</td>
<td>114</td>
<td>16.0</td>
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<td>Age when started to shave (years)</td>
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<tr>
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<td>27.0</td>
<td>195</td>
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<td>37.8</td>
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<td>17.9</td>
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<td>p\text{trend} = 0.04</td>
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* STEED, Servicemen’s Testicular Tumor Environmental and Endocrine Determinants.
† Logistic regression adjusted for matching factors (reference age, race, and serum date).
‡ Logistic regression adjusted for matching factors, cryptorchidism, and family history of testicular cancer.
dairy consumption in adulthood (12, 32, 33). At least two studies have reported associations with dietary fat and risk (19, 32), although the results have not been universally replicated (8, 33). In general, the support for an association with milk and risk is weak. Thus far, the current study is the only one to examine dairy intake in childhood, and the hypothesis found little support. Although there was a statistically significant association in the current study between consumption of 2 percent milk and TGCTs, the finding should be interpreted cautiously as it was not an a priori hypothesis. In specific, the findings did not suggest an association between dairy intake at the earliest ages (birth to kindergarten) and risk. As adult height is largely determined in the period between birth and age 2 years (24), nutrition at this age may be particularly relevant to TGCT risk. It is conceivable that the age interval used in the current study was too broad (birth to approximately age 6 years) to capture the risk associated with consumption in the first 2 years of life. In addition, there was not great diversity in dairy consumption in the current study, so an effect of dairy consumption may have been difficult to detect. Future studies may profit by focusing more finely on dairy consumption at very young ages and in populations where some diversity in consumption exists.

The previously published ecologic study correlating dairy intake with risk prompted the current study to also examine a relation with lactose intolerance. Given that populations of Northern European ancestry have the highest incidence of TGCTs in the world and tend to have a lower incidence of lactose intolerance than other populations (34), it was possible that the observed risk might be related to lactose tolerance rather than to dairy consumption per se. The present study found no evidence that this was the case, although the low frequency of lactose intolerance, which was almost certainly underestimated, may have permitted little power to test the hypothesis.

As height, nutrition, and age at puberty have all been associated with TGCTs and tend to be related to one another, the age at puberty was also examined in the current study. Previous studies of age at puberty and TGCTs have produced inconsistent results. Although Moss et al. (35) reported increased risk associated with earlier puberty (<14 years), four subsequent studies (20–23) reported a decreased risk associated with later puberty (≥17 years). Three studies, including the present one, reported no association with risk (7, 36). It is, perhaps, not surprising that the puberty results vary, given that there is no single benchmark event associated with the onset of male puberty as there is with female puberty. In addition, some studies have asked men to report their age at certain events (such as voice changing), while other studies have asked men to report the timing of the events for themselves in relation to the timing in peers.

If there is a protective TGCT association with later age at puberty, it is likely to be operating through a mechanism different from height, as the associated risks go in opposite directions. In general, later age at puberty results in greater adult stature due to the later fusion of the epiphyses of the long bones (37). Current thinking suggests, however, that the population trends in height and age at puberty are driven by different influences, as height has increased in most populations for the past 150 years, but age at puberty has, until recently, declined (37). Both phenomena are influenced by nutrition, but height appears to be associated with nutrition prior to age 2 years, while age at puberty is associated with nutrition between the ages of 2 and 8 years (24). A better understanding of the determinants of height and age at puberty may prove critical to improving the current knowledge of TGCT risk factors.

The advantages of the current study include that cases and controls were drawn from the same well-defined population (military servicemen) and that the response rate was high. In addition, the male US military population is not limited to a single geographic area or subset of the population, which makes results from this study generalizable to other populations. The study also included only pathologically confirmed testicular germ cell tumors, suggesting that the results are somewhat more precise than studies that have enrolled participants without regard to histology or confirmation of diagnoses. Study limitations include that some potential participants could not be contacted because of deployment, that participants were asked to remember events that happened years in the past, and that the analysis depended on self-reported body size rather than measured body size. The inability to contact men due to deployment presents a potential bias in that deployed men might be different in some way that nondeployed men are. As most young men in military service are healthy and fit, however, it would seem unlikely that deployment would confer substantial bias. The reliance on memory of events in the past is common to most case-control studies and is difficult to avoid when researching rare tumors, especially tumors that may have an early life etiology. The concerns about examining self-reported body measures prompted the current study to do a sensitivity analysis comparing reported and self-reported body measures. The analysis found that there was moderately strong correlation between the measured and self-reported heights of the participants. In addition, the analysis suggested that the controls tended to overestimate their height slightly more than the cases, which would have the effect of biasing the height results toward the null. It is possible, then, that height has more of an effect on TGCT risk than the data indicated.

In conclusion, the current study suggests that risk of TGCTs is associated with greater adult height, but not with age at puberty or milk consumption in childhood. More focused examinations of diet and other environmental influences on height at a very young age may prove beneficial to a better understanding of TGCT etiology.

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