

## Original Article

# Dietary supplement usage among elementary school children in Taiwan: their school performance and emotional status

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Dietary supplement consumption practices among 2417 children (1295 boys and 1122 girls) aged 6 to 12 years in Taiwan were derived from the Nutrition and Health Survey in Taiwan Elementary School Children (NAHSIT 2001-2002). The proportion (22%) of boys and girls using supplements was equivalent. Some 77% of the child supplement takers took only one type of supplement. The top five supplements consumed were: multivitamins and minerals, calcium, vitamin C, cod-liver oil and bee propolis in that order. Children in the most urbanized southern Taiwan had the highest usage (33%), but prevalence was lowest in the mountainous areas (5%). Higher parental education level and household monthly income were associated with higher intakes. Supplement users were more competent at school; however, the frequency and number of supplement types were not related to competence.

**Key Words:** dietary supplements, elementary school children, school performance, emotion, cognition

## INTRODUCTION

Various factors have led to the practice of dietary supplementation in the marketplace. Japanese research on the popularity of dietary supplements has found that mass media broadcasts, universal health insurance and medical care, and improved economic status have been three influential factors.<sup>1</sup> Lin and Chang found that dietary supplements have been in the market for more than 30 years in Taiwan. In 1995-96 sales peaked at NT\$25 billion, and accounted for NT\$23 billion in 2004. Most consumers bought their supplements from multiple marketing channels and imported products are the leading sources.<sup>2,3</sup> There has also been a marked increase in the use of supplements in other countries such as the USA. In 2004, expenditure on dietary supplements in the US was US\$14.9 billion. Vitamins and minerals were the most highly consumed important products (US\$8 billion) and accounted for about 54% of expenditure.<sup>4,5</sup>

The findings of the Nutrition and Health Survey in Taiwan 1993-1996 (NAHSIT 1993-1996)<sup>6</sup> and the Elderly Nutrition and Health Survey in Taiwan (Elderly NAHSIT, 1999-2000)<sup>7,8</sup>, suggest that about 20 to 30% of Taiwanese over the age of 13 use dietary supplements. Taiwanese women use more supplements than men apart those from aged 13 to 18. About 80% of elderly people aged over 65

and almost half of those in younger age groups who take dietary supplements, do so regularly.<sup>6-8</sup> In addition, both of these surveys found that urbanized populations with a higher level of education were more likely to take dietary supplements. Research in other countries has also found that usage of dietary supplements is higher in women, Caucasians, the elderly, and those with higher levels of education<sup>9-12</sup> and in urbanized settings. In Lin's report, the elderly, women (particularly menopausal and pregnant women) and children are the most important consumer groups, and vitamins and minerals are the principal supplements taken by people in Taiwan.<sup>13</sup>

The usage of dietary supplements has been studied for those aged 13 years and over in Taiwan.<sup>6-8</sup> However, information is scarce on the kinds of dietary supplements ingested by children and little is known about the purpose and motivation underlying their use.

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Dietary supplementation as an intervention for children with emotionality and cognition has aroused generated considerable interest in recent years. Foods ingested may influence children attention, conduct disorder and mood in a number of ways. Potential factors include malnutrition, types of diet, eating habits, pharmacological effects, food allergy, fatty acid deficiency and possibly food additives.<sup>14</sup> There is growing evidence that the provision of glucose may influence both memory and mood, particularly when intense metabolic demands are placed on the brain.<sup>15</sup> According to Benton<sup>16</sup>, a low glycemic index (GI) rather than high GI diet allowed better cognitive performances in humans, especially in the late morning (150 and 210 min after breakfast). The findings also indicated that individual with better glucose tolerance has better mood and memory.<sup>17,18</sup> In addition, research has also shown that supplementation with poly-unsaturated fatty acids could decrease violence although there was no evidence of an influence on hyperactivity.<sup>19</sup> Highly unsaturated fatty acids (HUFAs) were known to play an important role in many aspects of physical health, and may also play a role in a wide range of neuro-developmental and psychiatric conditions.<sup>14</sup> Children with attention deficit hyperactivity disorder (ADHD, subtype of emotional disturbance) have been shown in several studies to have low blood levels of HUFAs.<sup>20-22</sup> Increasing HUFA levels via dietary supplements could enhance brain function and reduce ADHD symptoms. Furthermore, a well-illustrated review article<sup>19</sup> showed that there are three well-designed trials in which multivitamin and mineral supplementation could decrease violent incidence and non-violent anti-social behavior. A range of micro-nutrients is likely to play a role in the metabolism of neurotransmitters known to modulate aggressive behavior.

The objective of this study was to investigate dietary supplements usage pattern among children aged 6 to 12 and to identify factors that influence these patterns. The following three topics are considered: 1) the relationship between demographic characteristics of children and the use of dietary supplements; 2) the types of dietary supplements used; 3) the relationship between emotional disturbance and use of dietary supplements.

This information should be useful for policy-making and the regulations of dietary supplements and health foods, as well as for education and health promotion.

## MATERIALS AND METHODS

### *Data sources*

Data in this study were collected as part of the Nutrition and Health Survey in Taiwan Elementary School Children (NAHSIT Children 2001-2002). The survey adopted a stratified two-stage complex sampling scheme. With respect to stratification, towns and districts in Taiwan with particular ethnic and geographical characteristics were designated into 13 strata including Hakka areas, Mountain areas, Eastern areas, Penghu Islands, 3 Northern regions, 3 Central regions and 3 Southern regions. Eight schools were first selected from each stratum using probabilities proportional to sizes method. 24 children were then randomly selected from each school. The survey included household interview and health examination. Informed consent was given by one of the parents of each

child. The study was approved by the Department of Health in Taiwan.<sup>23</sup> A total of 2417 participants (1295 boys and 1122 girls) were analyzed in this study.

### *Data operation and implementation*

Information used included household information, demographics and patterns of supplement usage. Children's parents and/or the main care-giver and main food provider were interviewed about their demographics, eating and child rearing practices. Teachers were asked to provide the overall school performance of the children. Performance was assessed using a modified version of the Scale for Assessing Emotional Disturbance (SAED) developed by Epstein and Cullinan in 1998.<sup>24,25</sup> The SAED is a standardized, norm referenced scale designed to assist in the identification of children who qualify for special education in "emotional disturbance"(ED). The SAED contains 52 items (7 positive and 45 negative questions about emotion), and a single item that focuses on overall school competence. Teachers were asked to rate each item on the following Likert-type scale: 0=not a problem; 1=mild problem; 2=considerable problem; 3=severe problem. In addition, the 7 positive and 45 negative emotional questions on the emotional disturbance scale were respectively combined to give an overall score. The original data were weighted to generate nationally representative estimates.<sup>23</sup>

### *Classification of dietary supplements*

We assess the prevalence of supplement use, the type used, regularity of use and use of single or multiple supplements. Supplements, health foods and functional foods were all referred to as 'Dietary supplements' regardless of which types of foods they were considered to be by the general public. Based on the nutritional characteristics of the supplements, we classified dietary supplements in this study into eight categories for descriptive statistics: "vitamins and minerals", "vitamins", "minerals", "lipids", "Chinese herbal", "protein and formula food", "other health promotional foods" and "unknown". The "unknown" was defined as supplement without clear label or definite components. Moreover, dietary supplements were also broadly categorized as 'Nutritional supplements', 'Other supplements' and 'Both types' for multiple regression analysis. 'Nutritional supplements' were related to vitamin or mineral supplements, 'Other supplements' included all supplements except 'Nutritional supplements'. 'Both types' was represented by the children taking 'Nutritional supplements' with 'Other supplements' in the meantime.

### *Statistical analysis*

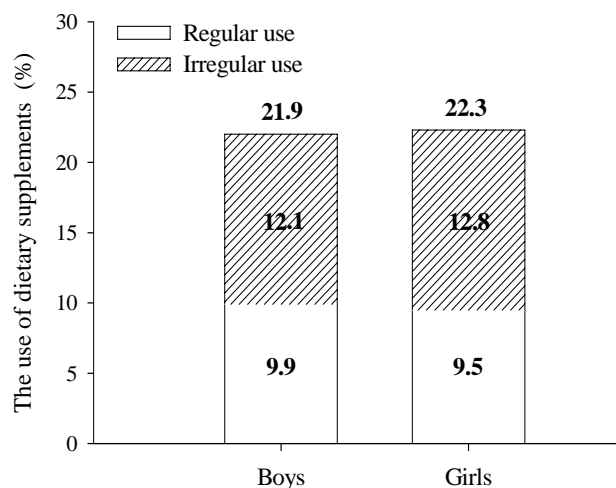
Descriptive statistics and correlation coefficients were used to compare the children's usage of dietary supplements across household information and demographic groups. Multiple regression analysis in the general linear model (GLM) was carried out on the relationship between usage of dietary supplements and children's scores on SAED after adjusting for the potential confounders of sex, age, parental education level and geographical location. All analyses were carried out using the Windows version of SAS 8.02. Statistical significance was all taken as  $p <$

0.05.

## Results

### *The relationship between demographic characteristics of children and the use of dietary supplements*

An average of 21.9% of boys and 22.3% of girls used dietary supplements (Fig. 1). The percentage of boys and girls using supplements was roughly equivalent. Out of those using dietary supplements, 45.0% of boys and 42.6% of girls used them regularly. This is slightly lower than the proportion of children using supplements irregularly (55.0% of them are boys and 57.4% of girls). The percentage of children using dietary supplements declined with age from 26.9% at age 6 to 18.1% at age 12. Girls aged 6 had the highest rate of supplement use (32.8%). Boys aged 12 had the lowest rate of supplement use (11.4%). The distribution of dietary supplement usage by geographical location is shown in table 1. Children in the most urbanized southern stratum had the highest prevalence of dietary supplement use (33.2%), followed by the medium-urbanized northern stratum (30.7%). The lowest prevalence of supplement use was found in the mountainous areas stratum (4.9%), followed by the low-urbanized central stratum (11.8%). Usage rates across areas were fairly similar for boys and girls. Boys in the Penghu Islands, 1st and 3rd stratum of northern areas, 2nd stratum of central areas, 1st and 2nd stratum of southern areas had a higher prevalence of dietary supplement use than girls. Out of those who took supplements, the proportion using supplements regularly was greater than 60% for the following groups: boys in mountainous areas (64.4%), girls in mountainous areas (84.1%) and children in Hakka areas (65.2%).



**Figure 1.** The relationship between gender and the use of dietary supplements. Sample size of boys and girls were 970 and 967 respectively.

The prevalence of dietary supplement use by children whose fathers and mothers have a university or higher education was 39.6% and 33.8%, respectively. This was higher than the prevalence of 14.1% and 12.0% respectively in children whose fathers and mothers have a primary school education or less education (Table 2). The prevalence of dietary supplement use was the highest at 32.8% and 30.0% respectively in children whose fathers or mothers had a household income of more than NT\$110,000 a month. The percentage of using dietary supplements was the lowest at 6.1% and 6.7% in children whose fathers or mothers had household income of under NT\$10,000 a month (Table 2). Higher parental education level and higher monthly household income were associated with a higher prevalence of dietary supplement use

**Table 1.** Child usage of dietary supplements by gender and region

| region                      | Sample size | Dietary supplements usage  |                    |                         |                         |                     |                       |                     |  |  |
|-----------------------------|-------------|----------------------------|--------------------|-------------------------|-------------------------|---------------------|-----------------------|---------------------|--|--|
|                             |             | Usage rate of children (%) | Boys (%)           |                         |                         |                     | Girls (%)             |                     |  |  |
|                             |             |                            | Usage rate of boys | Rate of irregular use   | Rate of regular use     | Usage rate of girls | Rate of irregular use | Rate of regular use |  |  |
| Hakka areas                 | 148         | 15.0                       | 13.7               | 9.0 (66.1) <sup>†</sup> | 4.6 (33.9) <sup>†</sup> | 16.4                | 5.7 (34.8)            | 10.7 (65.2)         |  |  |
| Mountain areas              | 143         | 4.9                        | 4.1                | 1.5 (35.6)              | 2.6 (64.4)              | 5.8                 | 0.9 (15.9)            | 4.9 (84.1)          |  |  |
| Eastern areas               | 152         | 15.3                       | 13.9               | 9.2 (66.1)              | 4.7 (33.9)              | 16.7                | 9.4 (55.9)            | 7.4 (44.1)          |  |  |
| PengHu islands              | 150         | 15.3                       | 16.3               | 13.5 (82.6)             | 2.8 (17.4)              | 14.1                | 8.7 (61.7)            | 5.4 (38.3)          |  |  |
| Northern areas: 1st stratum | 146         | 27.0                       | 29.2               | 16.9 (58.1)             | 12.2 (41.9)             | 24.7                | 14.8 (59.9)           | 9.9 (40.1)          |  |  |
| Northern areas: 2nd stratum | 148         | 30.7                       | 29.3               | 14.6 (49.9)             | 14.7 (50.1)             | 32.1                | 18.6 (57.8)           | 13.6 (42.2)         |  |  |
| Northern areas: 3rd stratum | 153         | 24.0                       | 27.7               | 13.1 (47.1)             | 14.7 (52.9)             | 20.0                | 12.3 (61.4)           | 7.7 (38.6)          |  |  |
| Central areas: 1st stratum  | 141         | 18.4                       | 14.7               | 10.9 (74.0)             | 3.8 (26.0)              | 22.5                | 11.2 (49.7)           | 11.3 (50.3)         |  |  |
| Central areas: 2nd stratum  | 145         | 18.9                       | 19.8               | 8.1 (40.9)              | 11.7 (59.1)             | 18.0                | 13.0 (72.5)           | 4.9 (27.5)          |  |  |
| Central areas: 3rd stratum  | 154         | 11.8                       | 9.3                | 4.2 (44.6)              | 5.2 (55.4)              | 14.4                | 10.0 (69.1)           | 4.5 (30.9)          |  |  |
| Southern areas: 1st stratum | 152         | 33.2                       | 34.2               | 21.4 (62.5)             | 12.8 (37.5)             | 32.1                | 17.1 (53.2)           | 15.0 (46.8)         |  |  |
| Southern areas: 2nd stratum | 152         | 27.9                       | 28.4               | 14.3 (50.6)             | 14.0 (49.4)             | 27.3                | 15.1 (55.2)           | 12.3 (44.8)         |  |  |
| Southern areas: 3rd stratum | 153         | 12.9                       | 10.9               | 6.2 (57.3)              | 4.7 (42.7)              | 15.1                | 10.0 (65.9)           | 5.2 (34.1)          |  |  |

<sup>†</sup> indicates the proportion of children using dietary supplements by irregular or regular use.

**Table 2.** The prevalence of supplement use by children according to education level, monthly household income, monthly disposable income and current employment of parent

|  | Fathers     |  | Mothers     |  |
|--|-------------|--|-------------|--|
|  | Sample size | Percentage of children using supplements | Sample size | Percentage of children using supplements |
| Education level                                  |             |  |             |  |
| Primary school and below                         | 223         | 14.1                                     | 254         | 12.0                                     |
| Junior high school                               | 604         | 15.4                                     | 576         | 16.1                                     |
| Senior high school                               | 907         | 22.7                                     | 1131        | 22.6                                     |
| College or University                            | 575         | 29.0                                     | 396         | 34.0                                     |
| Graduate or higher                               | 50          | 39.6                                     | 15          | 33.8                                     |
| Household monthly income (NT dollars)            |             |  |             |  |
| Less than 9,999                                  | 62          | 6.1                                      | 59          | 6.7                                      |
| 10,000-29,999                                    | 242         | 11.4                                     | 285         | 15.2                                     |
| 30,000-49,999                                    | 564         | 19.1                                     | 553         | 20.5                                     |
| 50,000-69,999                                    | 507         | 25.1                                     | 512         | 24.6                                     |
| 70,000-89,999                                    | 262         | 25.4                                     | 260         | 23.4                                     |
| 90,000-109,999                                   | 231         | 29.0                                     | 234         | 30.9                                     |
| More than 110,000                                | 159         | 32.8                                     | 164         | 30.0                                     |
| Disposable monthly income (NT dollars)           |             |  |             |  |
| Less than 4,999                                  | 86          | 12.8                                     | 88          | 11.7                                     |
| 5,000-19,999                                     | 617         | 18.4                                     | 661         | 19.7                                     |
| 20,000-39,999                                    | 860         | 24.2                                     | 878         | 22.7                                     |
| 40,000-59,999                                    | 272         | 29.0                                     | 272         | 30.1                                     |
| 60,000-79,999                                    | 81          | 34.6                                     | 83          | 37.2                                     |
| 80,000-99,999                                    | 41          | 34.4                                     | 46          | 31.8                                     |
| More than 100,000                                | 34          | 20.7                                     | 27          | 19.6                                     |
| Occupation                                       |             |  |             |  |
| Agriculture, forestry, fishing, animal husbandry | 179         | 8.4                                      | 56          | 13.0                                     |
| Mining   | 189         | 26.0                                     | 3           | 0.0                                      |
| Water and electricity                            | 44          | 19.0                                     | 6           | 24.1                                     |
| Construction                                     | 190         | 19.2                                     | 359         | 34.4                                     |
| Commerce   | 260         | 28.7                                     | 179         | 23.9                                     |
| Transport and communications                     | 114         | 29.7                                     | 20          | 63.3                                     |
| Finance and business                             | 173         | 25.6                                     | 1659        | 27.2                                     |
| Service industries                               | 354         | 21.0                                     | 297         | 20.1                                     |
| Manufacturing                                    | 200         | 19.3                                     | 141         | 16.7                                     |
| Other  | 104         | 22.0                                     | 739         | 20.4                                     |

in children. The prevalence of dietary supplement use was the highest (at 34.6% and 37.2% respectively) when fathers and mothers could afford the living expenses of NT\$60,000 to 80,000 a month. However, the prevalence of dietary supplement use dropped to about 20% when fathers and mothers could afford the living expenses of NT\$100,000 or below 200,000 (Table 2). Therefore, monthly parental disposable income had no positive association with the prevalence of dietary supplement usage.

The prevalence of dietary supplement use by children whose fathers and mothers work in the "transport and communications" fields was the highest at 29.7% and 63.3% respectively. The second highest prevalence was at 28.7% when children's fathers work in the "commerce" fields and at 34.4% when children's mothers work in the "construction" industry (Table 2).

There was no relationship between children's or parent's self-perception of being unhealthy and the prevalence of use of dietary supplements in children. There was also no relationship between parental self-perception of poor personal eating habits and the prevalence of use of dietary supplements in children. However, there was a positive but small association between children's self-perception of poor personal eating habits and use of supplements ( $r = 0.05$ ,  $p = 0.02$ ). Children with self per-

ceived good eating habits had a higher prevalence of dietary supplement use (24.4%) than children who had self perceived poor eating habits (18.7%).

#### *The types of dietary supplements*

Based on the nutritional characteristics of the supplements, dietary supplements were divided into eight categories (see in the materials and methods). Among all of these dietary supplements, the highest percentage use was of vitamins and minerals (35.9%), followed by vitamins at 30.8%, minerals at 18.6%, other health promotion foods at 15.8%, unknown at 8.2%, Chinese herbal at 6.4%, and lipids at 4.7%. The lowest percentage use was of protein and formula food at 3.1%. In the vitamins category, the highest consumption was of vitamin C (15.2%), followed by cod-liver oil (12.5%). In those who took minerals, the most popular item was calcium (17.9%). In those who took vitamins and minerals, the most popular item was multivitamins and minerals (30.3%), followed by cod-liver oil with calcium (3.5%). In the lipids category, the most popular item was fish oil (2.9%). In the protein and formula food category, the most frequently consumed item was goat's or sheep's milk tablets (2.1%). In the Chinese herbal category, the most popular item was ginseng and undefined Chinese herbal (2.2%). In the

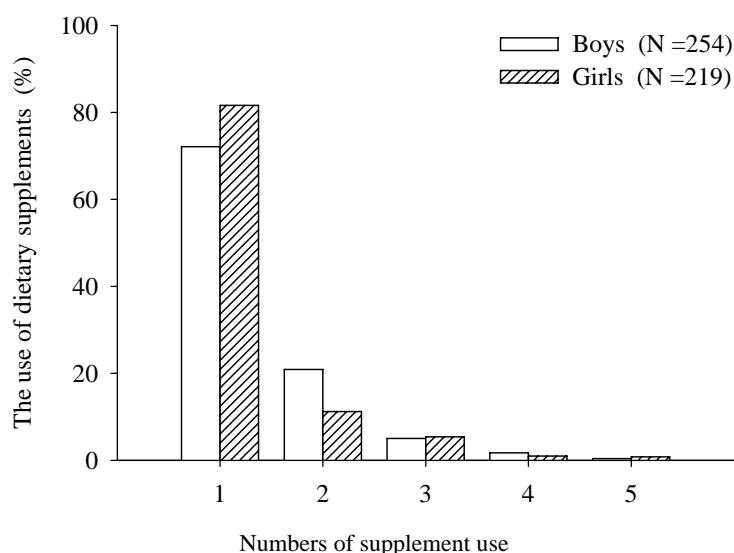


Figure 2. Distribution of numbers of dietary supplements used by elementary school children.

Table 3. Top ten dietary supplements used by elementary school children

| Rank | Children (%)  | Boys (%)                              | Girls (%)   |
|------|---|---------------------------------------|---|
| 1    | Multivitamins and minerals (30.3%)  | Multivitamins and minerals (30.0%)    | Multivitamins and minerals (30.6%)                        |
| 2    | Calcium (17.9%)   | Calcium (16.6%)                       | Calcium (19.2%)   |
| 3    | Vitamin C (15.2%)   | Vitamin C (15.5%)                     | Vitamin C (15.0%)   |
| 4    | Cod-liver oil (12.5%)   | Cod-liver oil (14.9%)                 | Cod-liver oil (9.8%)                                      |
| 5    | Bee propolis (4.2%)   | Bee propolis (5.8%)                   | Cod-liver oil with calcium (3.5%),<br>Chinese herb (3.5%) |
| 6    | Cod-liver oil with calcium (3.5%)   | Cod-liver oil with calcium (3.5%)     | Ginseng (3.4%)  |
| 7    | Fish oil (2.9%)   | Fish oil (2.9%)                       | Chicken essence (2.7%)                                    |
| 8    | Chicken essence (2.7%)  | Chicken essence (2.6%)                | Lactobacillus (2.6%),<br>Fish oil (2.6%)                  |
| 9    | Ginseng (2.2%),<br>Chinese herb (2.2%)  | Goat's or sheep's milk tablets (2.4%) | Bee propolis (2.5%)                                       |
| 10   | Lactobacillus (2.1%),<br>Goat's or sheep's milk tablets (2.1%),<br>Vitamin E (2.1%) | Vitamin B-complex (2.3%)              | Yeast (2.4%)  |

other health promotional foods category, the most popular item was bee propolis (4.2%). About 76.7% of boys (72.1%) and girls (81.6%) taking dietary supplements only took one type of dietary supplement. The numbers of children taking supplements decreased as the total number of supplement types chosen increased (Fig 2).

Table 2 shows the top ten dietary supplements consumed by children. The most popular supplements taken by boys were: multivitamins and minerals, calcium, vitamin C, cod-liver oil, bee propolis, cod-liver oil with calcium, fish oil, chicken essence, goat's or sheep's milk tablets, vitamin B-complex. The top ten dietary supplements taken by girls were: multivitamins and minerals, calcium, vitamin C, cod-liver oil, cod-liver oil with calcium and Chinese herb, ginseng, chicken essence, Lactobacillus and fish oil, bee propolis, yeast. Considering more than 1% difference from usage rates of supplements, the major difference between boys and girls for the ten most popular items was that boys' parents tended to choose more cod-liver oil, bee propolis and vitamin B-complex than girls. Girls' parents tended to take more calcium, Chinese herb, ginseng and yeast than boys.

#### ***The relationship between emotional disturbance and use of dietary supplements***

Table 4 indicates that children who took "Nutritional supplements" had better cognitive performance, better overall school academic performance, were more motivated towards learning at school and higher positive emotion scores ( $p < 0.05$ ). They were less likely to lack self esteem and have feelings of lack of self worth ( $p < 0.05$ ). They had a lower level of influence on emotions ( $p < 0.05$ ). However, they were more likely to have physical fights with others at school and showed more nervous behavior ( $p < 0.05$ ). Children who took 'Other supplements' had better cognitive performance and overall school academic performance ( $p < 0.05$ ). They were less likely to be unable to finish homework on their own, lack self esteem and have poor reading ability ( $p < 0.05$ ). Students who took 'Both types' of supplements had better overall school academic performance and were less likely to lie, cheat and steal, feel a lack of self worth and have trouble with homework ( $p < 0.05$ ). Children who took dietary supplements had more positive emotions. However, the overall score for negative emotions did not

**Table 4.** The relationship between types of dietary supplements and emotional disturbance of children †

| Emotional disturbance status                        | Sample size | Dietary supplements <sup>§</sup> | Adjusted Mean±SE | Coefficient | R <sup>2</sup> | GLM <i>p</i> value |
|---|-------------|----------------------------------|------------------|-------------|----------------|--------------------|
| 1. Cognitive performance                            | 121         | Other supplements                | 3.18±0.20        | 0.17        | 0.12           | 0.024*             |
|   | 295         | Nutritional supplements          | 3.14±0.20        | 0.13        |                | 0.005*             |
|   | 46          | Both types                       | 3.01±0.23        | 0.01        |                | 0.953              |
|   | 1857        | No use                           | 3.01±0.19        |             |                |                    |
| 2. Overall school academic performance              | 121         | Other supplements                | 2.78±0.22        | 0.18        | 0.14           | 0.020*             |
|   | 295         | Nutritional supplements          | 2.71±0.21        | 0.12        |                | 0.017*             |
|   | 46          | Both types                       | 2.87±0.24        | 0.28        |                | 0.032*             |
|   | 1857        | No use                           | 2.59±0.20        |             |                |                    |
| 3. Motivated towards learning at school             | 121         | Other supplements                | 2.57±0.23        | 0.12        | 0.12           | 0.163              |
|   | 295         | Nutritional supplements          | 2.57±0.22        | 0.12        |                | 0.030*             |
|   | 46          | Both types                       | 2.65±0.26        | 0.20        |                | 0.151              |
|   | 1857        | No use                           | 2.45±0.22        |             |                |                    |
| 4. Difficulties in completing homework on their own | 121         | Other supplements                | 0.50±0.16        | -0.13       | 0.08           | 0.026*             |
|   | 295         | Nutritional supplements          | 0.58±0.15        | -0.05       |                | 0.204              |
|   | 46          | Both types                       | 0.51±0.18        | -0.12       |                | 0.195              |
|   | 1856        | No use                           | 0.63±0.15        |             |                |                    |
| 5. Lie, cheat and steal                             | 121         | Other supplements                | 0.59±0.12        | -0.04       | 0.05           | 0.372              |
|   | 295         | Nutritional supplements          | 0.66±0.11        | 0.03        |                | 0.212              |
|   | 46          | Both types                       | 0.48±0.13        | -0.14       |                | 0.043*             |
|   | 1856        | No use                           | 0.63±0.11        |             |                |                    |
| 6. Lack self esteem                                 | 121         | Other supplements                | 0.49±0.19        | -0.14       | 0.06           | 0.029*             |
|   | 295         | Nutritional supplements          | 0.53±0.17        | -0.10       |                | 0.014*             |
|   | 46          | Both types                       | 0.51±0.20        | -0.12       |                | 0.254              |
|   | 1856        | No use                           | 0.63±0.17        |             |                |                    |
| 7. Feel a lack of self worth                        | 121         | Other supplements                | 0.23±0.10        | -0.06       | 0.05           | 0.105              |
|   | 295         | Nutritional supplements          | 0.24±0.10        | -0.05       |                | 0.029*             |
|   | 46          | Both types                       | 0.15±0.11        | -0.14       |                | 0.024*             |
|   | 1856        | No use                           | 0.29±0.10        |             |                |                    |
| 8. Trouble with homework                            | 121         | Other supplements                | 0.59±0.17        | -0.05       | 0.09           | 0.364              |
|   | 295         | Nutritional supplements          | 0.58±0.16        | -0.05       |                | 0.190              |
|   | 46          | Both types                       | 0.44±0.18        | -0.20       |                | 0.047*             |
|   | 1856        | No use                           | 0.63±0.16        |             |                |                    |
| 9. Physical fights with others at school            | 121         | Other supplements                | 0.57±0.10        | -0.01       | 0.08           | 0.858              |
|   | 295         | Nutritional supplements          | 0.63±0.10        | 0.05        |                | 0.040*             |
|   | 46          | Both types                       | 0.54±0.11        | -0.04       |                | 0.515              |
|   | 1856        | No use                           | 0.58±0.10        |             |                |                    |
| 10. Nervous behavior                                | 121         | Other supplements                | 0.13±0.09        | 0.01        | 0.03           | 0.773              |
|   | 295         | Nutritional supplements          | 0.16±0.08        | 0.04        |                | 0.041*             |
|   | 46          | Both types                       | 0.09±0.09        | -0.03       |                | 0.604              |
|   | 1856        | No use                           | 0.12±0.08        |             |                |                    |
| 11. Poor reading ability                            | 121         | Other supplements                | 0.50±0.16        | -0.15       | 0.10           | 0.013*             |
|   | 295         | Nutritional supplements          | 0.58±0.16        | -0.06       |                | 0.099              |
|   | 46          | Both types                       | 0.47±0.18        | -0.18       |                | 0.064              |
|   | 1856        | No use                           | 0.65±0.15        |             |                |                    |
| 12. Level of influence on emotions                  | 121         | Other supplements                | 0.50±0.16        | -0.09       | 0.06           | 0.240              |
|   | 294         | Nutritional supplements          | 0.58±0.16        | -0.14       |                | 0.006*             |
|   | 46          | Both types                       | 0.47±0.18        | -0.21       |                | 0.106              |
|   | 1853        | No use                           | 0.65±0.15        |             |                |                    |
| 13. Overall scores for positive emotions            | 121         | Other supplements                | 20.1±1.15        | 0.74        | 0.15           | 0.075              |
|   | 295         | Nutritional supplements          | 20.0±1.10        | 0.57        |                | 0.035*             |
|   | 46          | Both types                       | 20.2±1.27        | 0.80        |                | 0.242              |
|   | 1857        | No use                           | 19.4±1.08        |             |                |                    |

† Data for insignificant difference items are not shown in the table. § 'Nutritional supplements' were relative to vitamin or mineral supplements. 'Other supplements' included all supplements except 'Nutritional supplements'. 'Both types' was represented by the children taking 'Nutritional supplements' with 'Other supplements' in the meantime. \* Statistical significance is taken as  $p < 0.05$ .

differ between children who took dietary supplements and who did not take them ( $p > 0.05$ ).

As far as the frequency and number of supplement use were concerned (data not shown), children who took dietary supplements irregularly had better cognitive performance than those who took them regularly ( $p < 0.05$ ). The possibility of self-harming behavior was lower in children who took the supplements regularly than those

who took them irregularly ( $p < 0.05$ ). However, children who took dietary supplements regularly had higher rates of nervous behavior ( $p < 0.05$ ). Furthermore, children who took two or more dietary supplements were less likely to have feelings of guilt or shamefulness than those who took only one type of supplement ( $p < 0.05$ ). Children who took two or more dietary supplements also had a lower level of influence on emotions ( $p < 0.05$ ). Other

items in the scale had no significant relationship with regularly or irregularly taking supplement, or taking one versus two or more supplements. ( $p > 0.05$ ).

## DISCUSSION

Our study found that the prevalence of supplement use in both boys and girls aged 6-12 was similar. This is different from usage rates in the 13-18 year age group where boys have higher rates of supplement intakes than girls and in women aged 19 and over where women have higher rates of supplement usage than men.<sup>6-8,26</sup> Combining data from the previous NAHSIT survey and this study, we found that less than 50% of children aged 6-12, men aged 19-44 and girls aged 13-18 who take supplements do so on a regular basis. In other age groups (excluding children below the age of 5 years), more than 50% of the supplement takers took supplements regularly.<sup>6-8,26</sup> With regards to geographical location, low rates of supplement use in mountainous areas and in areas with lower level of urbanization were all found by the NAHSIT 1993-1996<sup>6</sup>, the Elderly NAHSIT<sup>7,8</sup> and in this study. Higher parental education level and household monthly income were associated with higher intakes of dietary supplements by children. This was also similar to results from the NAHSIT 1993-1996<sup>6</sup> and the Elderly NAHSIT<sup>7,8</sup>, and research in other countries showing higher rates of supplement use in women, Caucasians, the elderly, urbanized settings, the higher educated, and those with higher incomes.<sup>9-12</sup> Moreover, in the Elderly NAHSIT<sup>7,8</sup>, there was a direct association between high individual monthly income and increased intake of supplements, indicating that the use of supplements by the elderly is related to their personal economic status. However, as children are not economically independent, the use of dietary supplements may be more affected by household economic status.

Combined vitamin and mineral supplements and calcium supplements (mineral supplements) were the most popular supplements consumed by children aged 6-12. This might be related to the nutrition knowledge of the public that children need good nutrition for growth and development. In fact, calcium supplementation has been found to be beneficial for bone health in children, young adults, and menopausal women. In addition to calcium, vitamin D is necessary for bone health and is generally deficient in the industrialized world.<sup>27</sup> Children more commonly took bee propolis (Table 3), possibly due to the parental expectation for children in this age group to prevent colds and flu and strengthen the immune system.<sup>28</sup> In addition, children predominantly took fish oil, possibly due to the presence of health information indicating that n-3 long-chain polyunsaturated fatty acids and DHA contained in fish oil is helpful for children's neurological development.<sup>29,30</sup> Epidemiologic and experimental studies had indicated that consumption of more n-3 long-chain polyunsaturated fatty acids may reduce the risk for a variety of diseases, including cardiovascular, neurological and immunological disorders, diabetes and cancer.<sup>31</sup> Studies with nonhuman primates and human newborns indicated that DHA is essential for the normal functional development of the retina and brain, particularly in premature infants.<sup>32</sup>

Children who took dietary supplements showed more positive emotions and fewer negative emotions. However, when investigating the relationship between regularity of supplement use and number of supplements taken with emotional disturbance scores, it was found that taking supplements regularly and taking two or more supplements was not associated with higher scores for positive emotions (for example children who took supplements regularly did not have a relative increase in cognitive performance). Regular use or taking two or more supplements was also not associated with lower scores for negative emotions (for example children who took supplements regularly had higher rates of nervous behavior). The majority of the items on the emotional disturbance scale did not show any significant difference when supplements were taken regularly or when two or more supplements were taken. Therefore, the frequency and amount of supplements used by children is not significantly related to children's emotional reactions. As cross-sectional surveys are unable to establish causality, the reason behind increased positive emotions and decreased negative emotions in children taking dietary supplements is unclear. In a study by Lee,<sup>33</sup> it was shown that supplement use of children was predicted by mothers' beliefs, attitudes, perceptions, and practices regarding mothers' own eating and child feeding practices. Therefore, it is possible that interaction between parents and children are better in children with less emotional disturbance<sup>34</sup>, and that these improved interactions are highly associated with parents offering supplements to children.

In this study, about 22% of children took dietary supplements. Like other studies,<sup>35-37</sup> ours found that vitamins and/or minerals are the most commonly consumed dietary supplements. On the other hand, in a study by Wang,<sup>35</sup> 85.5% of subjects did not understand safe levels of intake of vitamins and minerals. There is potential for this lack of knowledge about safety in regards to supplement use to jeopardize Taiwanese health status. Furthermore, Lee<sup>38</sup> found that almost 50% of subjects believed that dietary supplements could be used in place of medications to treat disease, and almost 60% of subjects believed that dietary supplements could prevent disease. Moreover, consumers believe that any dietary supplements with a Health Department logo are trustworthy, and that dietary supplements from developed countries are of higher quality than locally made products. However, the majority of dietary supplements, including those advertised as benefiting health, have not been scientifically researched. Many putative benefits are exaggerated during advertising.<sup>39,40</sup> There is a wide variety in the level of safety and quality of these products. As the number of Taiwanese people using dietary supplements continues to increase, it is important to better understand the general public's perceptions and knowledge about dietary supplements as well as the marketing strategies used for each product. Communication between professionals and the public should be strengthened and members of the public educated to increase understanding of the special characteristics of dietary supplements. This would enable dietary supplements, where appropriate, to be more effectively used to improve health, as well as promote preventive medicine and decrease medical costs.

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## AUTHOR DISCLOSURES

Shih-Ying Chen, Jia-Rong Lin, Mei-Ding Kao, Chi-Ming Hang, Lieyueh Cheng, and Wen-Harn Pan, no conflicts of interest.

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## Original Article

## Dietary supplement usage among elementary school children in Taiwan: their school performance and emotional status

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### 臺灣國小學童攝取膳食補充品的現況-學童的學校表現與情緒狀態

2417 位 6 至 12 歲兒童（1295 位男孩和 1122 位女孩）攝取膳食補充品的現況分析，資料源自於 2001-2002 年臺灣國小學童營養健康狀況變遷調查。男童攝取補充品的比率(22%)與女童相同。77% 的兒童只攝取一種補充品。使用前五名的補充品，依序是：綜合維生素與礦物質、鈣質，維生素 C、魚肝油和蜂膠。臺灣南部都市化程度最高的地區，其兒童攝取補充品的比率最高(33%)，山地地區的兒童攝取比率最低(5%)。父母親的教育程度和家庭的每月收入較高，其兒童攝取補充品的比率也高。攝取補充品的兒童在學校的表現較能幹；然而，這種現象與攝取頻率和補充品的種類數目無關。

關鍵字：膳食補充品、國小學童、學校表現、情緒、認知。