

RESEARCH ARTICLE

THE REASON FOR VITAMIN-MINERAL SUPPLEMENT INTAKE AMONG SECONDARY SCHOOL ADOLESCENTS IN MALAYSIA AND ITS ASSOCIATION WITH NUTRITIONAL STATUS AND DIETARY PRACTICE

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ABSTRACT

Vitamin mineral supplement (VMS) consumption is prevalent among the population, particularly adolescents. However, literature about the factors associated with the reasons for consuming VMS has not been investigated in Malaysia, indeed adolescents' nutrition is important as they experience body change during this period. Thus, this cross-sectional, national health study aims to determine the association between nutritional status, dietary practice and reasons for VMS consumption among secondary schools in Malaysia. A total of 40,087 adolescents aged 10-18 completed the questionnaire. Among them, only 22.6% (9,077) of them from secondary school consumed VMS and were included in this study. Gender, height-for-age, strata, ethnicity, hunger experience, eating out and breakfast intake frequency were associated with the reasons for VMS intake. After the adjustment, stunted adolescents were more likely to consume VMS due to the doctor's prescription (RRR:1.51, 95% CI: 1.11-2.10). Adolescents who sometimes experienced hunger were more probable to consume VMS due to doctor's instruction, self-awareness and friends' influence as compared to other unspecified reasons (RRR: 1.41, 95% CI: 1.08-1.85; RRR 1.38, 95% CI: 1.07-1.77; RRR: 1.98, 95% CI: 1.27-3.08, respectively). No association was found between dietary behaviour and the reason for the VMS intake. For meal pattern, adolescents who skipped breakfast were less likely to consume VMS due to doctor's instruction, parents' advices and self-awareness (RRR: 0.53, 95% CI: 0.39-0.72; RRR: 0.50, 95% CI: 0.38-0.66; RRR: 0.59, 95% CI: 0.45-0.78, respectively). This study suggested that further studies were needed to investigate the role of VMS use in relation to nutrient adequacy, overconsumption and health.

KEYWORDS

Adolescent, dietary supplement, Malaysia, vitamin-mineral supplement

1. INTRODUCTION

In recent decades, the usage and availability of dietary supplements were dramatically increased due to the increasing health awareness among the public, especially after the sudden outbreak of the COVID-19 pandemic (Weerasena et al., 2021). According to Fortune Business Insights (2022), the global market size of dietary supplements was USD 71.81 billion (RM 318.66 billion) in 2021 and was expected to reach USD 128.64 billion (RM 570.84 billion) in 2028 at a compound annual growth rate (CAGR) of 8.68%. Interestingly, one-third of the market was contributed by vitamin and mineral supplements (VMS) (USD 20.16 billion) (Research and Markets, 2023). A similar trend goes to Malaysia, the dietary supplement market size has grown annually by 3.0% (CAGR 2018 – 2020), with a total of around USD 544 million (RM 2.2 billion) in 2020, and was believed to continue growing in the coming years (Koe, 2021; MADSA, 2019). All these statistics were strongly indicating that there is a high preference and demand from the population to purchase and consume dietary supplements in this modern life.

Dietary supplements are ingested products that are used to supplement the diet, which includes vitamins, minerals, amino acids, botanicals or herbs, botanical compounds and probiotics, and they may be in the forms of tablets, capsules, gummies, powders, soft gels, bars gel caps and liquids (FDA, 2022). Among all of these, as has been stated above, VMS is the most

common supplement that has been widely used worldwide, including in Malaysia (Council for Responsible Nutrition, 2019; Statista Research Department, 2022; Weerasena, 2021; Zhang et al., 2020). A recent national survey in United States reported that 34.8% of children and adolescents aged 0-19 years consumed dietary supplements in the past 30 days, and one-quarter of them used multivitamin-minerals, which claimed as the most used supplements, followed by vitamin D (3.0%) (Mishra et al., 2023). Likewise, Jeon et al. (2021) found that approximately 20.3% of children and adolescents were consuming dietary supplements and multivitamin-mineral supplements were the second highest frequently used supplements.

Findings from a national study among adolescents in Malaysia showed that 54.1% of them took VMS (Sien et al., 2014), while National Health and Morbidity Survey (NHMS) 2017 reported a lower prevalence which is 44.7% and both studies mentioned that vitamin C was the most popular supplement as compared to other VMS (Institute for Public Health, 2017). Another nationwide cross-sectional study in Malaysia revealed that about 28.1% of Malaysian adults consumed VMS during the past 1 year (Mohd Zaki et al., 2018). Additionally, Mohd Ashri et al. (2021) claimed that more than half (55.4%) of the government employees in Putrajaya consumed dietary supplements, mainly vitamin C, with a prevalence of 38.4%. This statistic was not limited to adults, but it might be also observed among adolescents. Since most studies of supplement use focus on adults, less

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information is available regarding the rationale for their use in adolescents. Indeed, nutrition in adolescence is a critical period that should be frequently observed as they shift to adulthood, and what they practising now will shape their health condition in future (Bundy et al., 2017).

Previous studies found that the reason for supplementation among adolescents was due to the parent's advice rather than doctors' instruction or other unspecified reasons (Lee et al., 2013; Sien et al., 2014). In another study by Ceschini et al. (2022), 29.3% of adolescents in the municipality of Brazil were found to consume VMS without any professional guidance (self-prescription). Additionally, a vast number of current findings highlighted that no matter whether adults or adolescents, the reason they consumed dietary supplements is to maintain and improve their overall health level, also to prevent diseases (Cebula et al., 2018; Elshoryi et al., 2023; Perlitz et al., 2019; Shahzad et al., 2022; Sicinska et al., 2022; Yazid et al., 202) as they believed that supplements help achieve their recommended nutrient intake (Hoover et al., 2017). This phenomenon was termed 'dietary insurance' (Whitney & Rolfes, 2018), whereby the concept is to improve the poor diet by simply taking a dietary supplement to 'cover up' poor dietary choices and is common among people who feel unsure about the nutritional adequacy of their diet. In view of that situation, it is not impossible to justify that some parents or adolescents implement a similar action for a similar reason. However, most of the study that discover the reason for supplementation was conducted in other countries, and only a little research was found in Malaysia, especially among adolescents.

Besides, a recent research study among university students in Jordan revealed that the body mass index (BMI) and dietary supplements showed a significant direct association, whereby students with higher BMI was likely to consume dietary supplement (Elshoryi et al., 2023). In contrast, some studies found that adults with normal BMI consumed significantly more dietary supplements (Aziz et al., 2020; Mohd Ashri et al., 2021; Žeželj et al., 2018). Nevertheless, there is also a study that claimed that lower BMI was associated with dietary supplement intake (Jeon et al., 2021). In short, the relationship between nutritional status and dietary supplement intake, particularly VMS is still inconsistent. Likewise, the previous studies found were mainly focused on the relationship between nutritional status and supplement intake, but not the reason for consuming dietary supplements.

Vitamins and minerals are micronutrients that are vital for the human body to develop and function normally as well as prevent diseases. Since it is called a micronutrient, thus it means that only a tiny amount is needed from the diet. Nevertheless, most people still consume VMS even though they already had met all the recommended nutrient intake (Zhang et al., 2020). For instance, the consumption of VMS was higher apparently in healthy people or people that engaged in healthy eating and lifestyle habits, such as high in whole grains (Rautiainen et al., 2014), fruits and vegetable intakes (Alwalan et al., 2022; Kang et al., 2017; Rautiainen et al., 2014) as well as did not skip breakfast (Jeon et al., 2021; Mohd Ashri et al., 2021). Although VMS is good in certain circumstances, it may bring negative side impacts, which are harmful to our body if it exceeds the tolerable upper intake level (Alwalan et al., 2022; Sirico et al., 2018). At present, vitamin toxicity and deficiency disease are not a medical curiosity as it rarely occurs or has not been encountered in the major health and nutrition surveys in countries including Malaysia. However, there is a need to know the association between the dietary practice and the reason for taking VMS, so that healthcare professionals can take a more appropriate action to prevent it from becoming a major health concern.

VMS intake also has been connected with the environment, demography and socioeconomic status. These studies highlighted that females, high socioeconomic status (Alhashem et al., 2022; Mohd Ashri et al., 2021; Mohd Zaki et al., 2018) and Indian (Sien et al., 2014) were more likely to consume VMS, while no significant difference was found between urban and rural adolescents in taking VMS (Institute for Public Health, 2017). However, it was unknown if these factors could be the influential factors for VMS intake advised by parents, peers, or doctors. In this study, we investigated whether there were significant connections between environmental, socioeconomic and demographic factors with the reason for taking VMS besides dietary practice and nutritional status of adolescents.

The reasons for taking supplements, such as not getting enough of the vitamin from their diet and their belief as less healthy without supplements are the areas of concern, especially for adolescents because the nutrient needs during adolescence are relatively high compared to adulthood (Bundy et al., 2017). Eating patterns and attitudes towards foods during adolescence can impact an individual's lifelong relationship

with food and nutrition (Desbrow, 2014). Thus, encouragement to practice healthy food habits by helping adolescents choose a sensible and healthful diet should be initiated by parents or older adults. The existing studies on VMS intake among adolescents were not as extensive as in adults; therefore, understanding the association of dietary practice and nutrition status with the reason for VMS intake could highlight the underlying reasons for supplement consumption and thus provide the appropriate health education for parents and nutrition action plans for the benefits of the children.

2. METHODS

2.1 Sampling

The Adolescent Health and Nutrition Survey 2018 was a cross-sectional, national health survey conducted by the Ministry of Health, Malaysia from March to May 2017 was a representative survey of Standard 4 to 6 (10-12 years of age) and Form 1 to 5 (13-17 years of age) school students. A total of 311 schools with 40,087 questionnaires for the Adolescent Nutrition survey, 2,021 Habitual Food intakes and 27,497 Adolescent Health Survey were completed by students. Eligible schools listed by the Ministry of Education were selected randomly at the first stage of sampling. Then, the schools were selected randomly with probability proportional to school enrolment size. The second stage of sampling was the selection of classes in the selected school by using systematic random sampling. The final stage sampling was applied to select students for the habitual food intake module. Out of 40,087 completed questionnaires, only 9,077 adolescents aged 13-17 years from secondary school, who consumed vitamin and mineral supplements, were included in this study. Ethical approvals of the study were obtained from the Medical Research and Ethics Committee (MREC), Ministry of Health Malaysia; Education Planning and Division (EPRD), Ministry of Education Malaysia prior to conducting the study. Informed written consent was taken from all respondents at the beginning of the study.

2.2 Measures

2.2.1 Vitamin Mineral Supplement (VMS)

Vitamin mineral supplement (VMS) is a component of a dietary supplement. The answer options were multivitamins, vitamin C, iron and others. Students were asked if they had taken any of VMS, the frequency of intake, and the reason for taking the VMS which, either due to doctor's prescription, parent's advice, self-awareness, friend influences or other unspecified reasons.

2.2.2 Nutritional Status

Nutritional status included anthropometry measurements of weight and height. Weight was measured by using a digital weighing scale (Tanita HD319, Japan) to the nearest 0.1 kg, whereas body height was assessed using the SECA body meter (SECA 206, Germany) to the nearest 0.1 cm. Measurements were taken in duplicate for each student, and the average value was computed. Based on the weight and height measurements, the BMI-for-age z score was calculated using WHO AnthroPlus (version 3.22) software and classified based on the BMI-for-age cut-off recommended by World Health Organization (WHO, 2020).

2.2.3 Dietary Practice

The dietary practice components consist of dietary behaviour and meal patterns of adolescents. In the dietary behaviour components, questions on hunger, fruit, vegetables, carbonated drink and fast food intake were asked. The frequency of intake refers to the intake of at least twice fruit and three times vegetables in the past 30 days. The frequency intake of fast food referred to whether they had been taking them at least for three days in the past seven days. The answer options were either 'Yes' or 'No'. Going hungry was defined as experiencing hunger most of the time or always due to inadequate food at home for active and healthy living. Meal pattern in this study is defined as eating frequency of breakfast, eating out, and snack food. The answer options either did not take/never to range of the days in a week.

2.2.4 Statistical Analyses

Data were analysed using SPSS version 22 (SPSS, IBM, New York, NY). Descriptive analysis was measured to determine the prevalence of VMS intake among adolescents. In the multinomial logistic regression test, the univariate multinomial logistic regression test was conducted prior to conducting the multivariate multinomial logistic regression test. The dependent variable in the analysis was the reasons for taking VMS, and other unspecified reasons became the reference category. Investigated

factors (demography, nutritional status, dietary behaviour and meal pattern) were tested individually in univariate analysis to identify their significance value displayed in the Likelihood Ratio Test table. Factors with p -value < 0.05 were selected for the multivariate test. The final model with $p < 0.05$ presented in the Parameter Estimates table indicated the significant factors associated with the reasons for VMS intake.

3. RESULTS

The National prevalence of VMS intake including students aged 10-12 years old was 44.7% (95% CI: 42.49-46.91). Of 40,087 students who completed the questionnaires, 9077 secondary school adolescents (aged 13-17 years old) reported consuming VMS. Vitamin C was the most frequently consumed VMS (69.5%) followed by others (11.5%), multivitamins (11.3%), and iron (7.7%). The VMS was taken commonly 1-2 times/week (35.0%) or daily (31.9%) by students. The top reason for taking VMS was due to parents' advice (42.9%) (Table 1).

Table 1: Vitamin and Mineral Consumption Characteristics Among Secondary School Adolescent in Malaysia

	Frequency n (%)
Type of vitamin (N=9077)	
Multivitamin	1027 (11.3%)
Vitamin C	6308 (69.5%)
Iron	697 (7.7%)
Others	1045 (11.5%)
Reason of taking	
Prescribed by doctor	1415 (15.6%)
Advised by parent	3960 (43.6%)
Self-awareness	2880 (31.7%)
Friend influence	207 (2.3%)
Other unspecified reasons	615 (6.8%)
Frequency of taking	
Everyday	2897 (31.9%)
5-6 times / week	1075 (11.8%)
3-4 times / week	1932 (21.3%)
1-2 times / week	3173 (35.0%)

Table 2 displayed the univariate multinomial logistic regression of nutritional status, demography factors, meal pattern and dietary behaviour based on the reasons for taking VMS. Intake of VMS among males versus females was less likely associated with parent's advice (RRR=0.68) but more likely due to friends' influences (RRR=2.32). Urban adolescents were more likely to consume VMS due to parent's advice compared to their counterparts (RRR=1.52). No other significant associations were observed among the reason for VMS intake and living strata of adolescents. By ethnicity, Chinese in comparison to 'other' ethnicities were less likely to take VMS due to doctor's instruction (RRR=0.43). Malay, Indian and other ethnicities did not show significant associations with any VMS prescription reasons.

Stunted adolescents were more likely to consume VMS (RRR=1.45) due to doctor's instructions. No other significant associations were found between stunted and other VMS intake reasons. BMI for age showed thin adolescents tended to consume VMS (RRR=2.49) due to friends' influence. No other significant association was observed between BMI for age status and reasons for VMS intake.

The reasons of VMS intake, including prescription by doctor, self-awareness and friend influences, were more likely observed among adolescents who sometimes experienced food hunger than those who were never hungry (RRR=1.50, doctor's instruction; RRR=1.40, self-awareness; RRR=1.98, friend's influence) respectively.

Adolescents who did not eat vegetables three times daily, compared to those who consumed vegetables at least three times daily, were more likely to consume VMS due to doctor's instruction (RRR=1.32) and parent's advice (RRR=1.27). Adolescents who did not consume soft

drinks were likely to take VMS due to parent's advice (RRR=1.26).

Adolescents that skipped breakfast were less likely to consume VMS due to doctor's instruction (RRR=0.53), parent's advice (RRR=0.54) and self-awareness (RRR=0.59). Adolescents who never ate outside and who ate outside daily were less likely to consume VMS due to parent's advice (RRR=0.71; RRR=0.25). No other significant findings were observed between eating frequency and other VMS prescription reasons.

Table 3 presents factors associated with VMS intake based on multivariate multinomial logistic regression analysis. The final model showed that adolescents who were male, stunted, sometimes experiencing hunger, and living in an urban area were more likely to take VMS due to a doctor's instruction, parent's advice, self-awareness or friends' influence. The analysis also showed that adolescents who were male, of Chinese ethnicity, ate out frequently (7 times a week) and did not take breakfast or had daily breakfast, were less likely to take VMS due to doctor's instruction, parent's advice, self-awareness or friends' influence. The final model presented significant associations of gender, height for age, strata, ethnicity, eating out frequency, hunger experience and breakfast intake with the reason for VMS intake (Table 3).

4. DISCUSSION

Vitamin mineral supplements (VMS) usage is increasing despite the lack of evidence of its benefit for most people, particularly in reducing the risk of non-communicable diseases (Zhang et al., 2020). Reasons for VMS intake are likely to be complex as it involves social, psychological, knowledge and economic factors. The result of this study showed that the main predictors for VMS consumption were due to parent's advice and followed by doctor's prescriptions and self-awareness. The finding highlights that gender, height for age, strata, ethnicity, hunger experience, eating out and breakfast intake frequency were associated with the reasons for VMS intake.

Based on gender differences, VMS intake among males was more prevalent due to the friends' influence and less likely due to the parent's advice when compared with other unspecified reasons. This finding was consistent with the NHMS 2017 where reported that male adolescents were more likely to consume VMS due to parent's advises (39.2%) (Institute for Public Health, 2017), but inconsistent with the study by Gallè et al. (2023), whereby they found that women had a higher prevalence of dietary supplement use and more often due to professionals' description, such as physicians and nutritionists. Also, a study in Korea reported that females were more likely to consume VMS as compared to males, but their most common reason to consume is in line with our study, which is due to recommendations from friends or acquaintances (Park et al., 2016). The justification may be because males were possibly more physically active and engaged with sports compared to females (Alfawaz et al., 2020; Institute for Public Health, 2017). For instance, in a previous local study among adolescents, boys as well as those physically active were twice as likely to consume VMS (Sien et al., 2014). The vitamin itself is incapable to enhance performance, but it is essential for the maintenance, production and recovery of bone and muscle tissue (Mancevska et al., 2020); therefore, the consumption of VMS might be driven by these reasons. Besides, the previous study reported that supplement users most likely were health conscious (Kofoed et al., 2015; O'Brien et al., 2017) which might have led them to consume VMS without an order from their guardian. Indeed, adolescence is a stage where they develop independence from parents and is often superseded by dependency on peers (Szwedo et al., 2017).

This study demonstrated that the environment and strata were associated with the VMS intake. Compared to adolescents from the rural area, the urban counterparts consumed VMS likely due to the parent's advice. The prevalence of VMS consumption among adolescents in urban and rural areas is consistent with the study by Lee et al. (2013), whereby the prevalence was higher in urban areas. As for what has been studied, there is no available study that investigates the association between locality and reasons for consuming VMS. In a study by Burnett et al. (2017), the authors reported that most of the adults who consumed VMS had higher educational attainment and were from areas reflecting the least socioeconomic disadvantage. Perhaps these findings might be revealed that parents from urban areas were more likely to influence the VMS intake among their children, as they might also be VMS users. However, the consumption of VMS among their parents was not assessed in this study.

Table 2: Factors Associated with VMS Prescription Based on Univariate Multinomial Logistic Analysis

	Doctor's instruction vs other unspecified reasons RRR (95% CI)	Parent's advices other unspecified reasons RRR (95% CI)	Self-awareness vs other unspecified reasons RRR (95% CI)	Friends influence vs other unspecified reasons RRR (95% CI)
Gender (n = 9077)				
Boy (n = 4795)	0.89 (0.73 – 1.07)	0.68 (0.58 – 0.81)**	1.10 (0.92 – 1.31)	2.32 (1.63 – 3.30)**
Girl (n = 4282)	1	1	1	1
Strata (n = 9077)				
Urban (n = 5430)	0.95 (0.78 – 1.14)	1.52 (1.28 – 1.80)**	1.30 (0.86 – 1.22)	0.85 (0.62 – 1.17)
Rural (n = 3647)	1	1	1	1
Ethnicity (n = 9077)				
Malay (n = 6107)	0.63 (0.34 – 1.18)	0.86 (0.47 – 1.54)	0.98 (0.54 – 1.80)	1.53 (0.43 – 5.44)
Chinese (n = 1287)	0.43 (0.22 – 0.86)*	1.14 (0.61 – 2.13)	0.86 (0.46 – 1.64)	1.20 (0.32 – 4.59)
Indian (n = 544)	1.54 (0.73 – 3.26)	1.28 (0.63 – 2.59)	1.11 (0.54 – 2.30)	1.17 (0.26 – 5.27)
Bumiputra Sabah (n = 610)	0.80 (0.39-1.62)	0.89 (0.46 – 1.74)	0.89 (0.44 – 1.72)	1.44 (0.36 – 5.82)
Bumiputra Sarawak (n = 314)	0.78 (0.35 – 1.74)	0.89 (0.42 – 1.87)	1.11 (0.52 – 2.39)	1.73 (0.39 – 7.76)
Others (n = 215)	1	1	1	1
Height for age (n = 9070)				
Stunted (n = 786)	1.45 (1.11 – 2.10)*	1.01 (0.74 – 1.38)	0.94 (0.68 – 1.29)	0.81 (0.44 – 1.49)
Normal (n = 8281)	1	1	1	1
BMI for age (n = 9071)				
Thinness (n = 683)	1.35 (0.85 – 2.15)	1.49 (0.97 – 2.29)	1.53 (0.99 – 2.37)	2.49 (1.20 – 5.16)*
Normal (n = 6048)	0.91 (0.68 – 1.22)	1.08 (0.83 – 1.41)	1.14 (0.87 – 1.49)	1.21 (0.71- 2.06)
Overweight (n = 1281)	0.88 (0.61 – 1.27)	1.06 (0.77 – 1.47)	1.03 (0.74 – 1.45)	1.44 (0.77 – 2.70)
Obese (n = 1059)	1	1	1	1
Experience of hunger (n = 9063)				
Never (n = 386)	1	1	1	1
Rare (n = 1867)	0.95 (0.76 – 1.19)	0.88 (0.72 – 1.07)	1.01 (0.83 – 1.24)	1.60 (1.10 – 2.32)*
Sometimes (n = 2655)	1.5 (1.15 – 1.96)**	1.24 (0.97 – 1.58)	1.40 (1.09-1.80)**	1.98 (1.28 – 3.06)**
Always (n = 4155)	0.89 (0.57 – 1.39)	0.77 (0.52 – 1.14)	0.74 (0.49 – 1.12)	1.75 (0.89 – 3.45)
Dietary behavior for the past month				
a) Fruit intake at least twice daily (n = 9055)				
Do not eat twice daily (n = 4440)	1.02 (0.85 – 1.24)	1.09 (0.92 – 1.30)	1.09 (0.92 – 1.30)	1.02 (0.75 – 1.40)
Eat twice daily (n = 4615)	1	1	1	1
b) Vegetable intake at least three times daily (n = 9050)				
Do not eat three times daily (n = 5726)	1.27 (0.102 – 1.56)*	1.32 (1.10 – 1.60)**	1.14 (0.94 – 1.38)	1.62 (1.11 – 2.37)*
Eat three times daily (n = 3324)	1	1	1	1
c) Fruit and vegetables intake at least five times daily (n = 9050)				
Not meet 2 serving fruit and 3 serving vegetable (n = 6773)	1.24 (0.89 – 1.73)	1.18 (0.87 – 1.59)	1.01 (0.75 – 1.38)	1.46 (0.82 – 2.58)
Meet 2 serving fruit and 3 serving vegetable (n = 2277)	1	1	1	1
d) Soft drink intake at least once a day (n = 9050)				
Do not consume once a day (n = 5515)	0.92 (0.76 – 1.11)	1.26 (1.06 – 1.50)*	1.08 (0.90 – 1.28)	0.86 (0.62 – 1.18)
Consume at least once in a day (n = 3535)	1	1	1	1
e) Consuming fast food at least 3 days in past 7 days (n = 9053)				
Do not eat fast food (n = 7839)	0.96 (0.74- 1.26)	1.15 (0.90 – 1.46)	1.11 (0.87 – 1.43)	0.72 (0.48 – 1.09)
Consume at least three day / week (n = 1214)	1	1	1	1

Table 2: Factors Associated with VMS Prescription Based on Univariate Multinomial Logistic Analysis

	Doctor's instruction vs other unspecified reasons RRR (95% CI)	Parent's advices other unspecified reasons RRR (95% CI)	Self-awareness vs other unspecified reasons RRR (95% CI)	Friends influence vs other unspecified reasons RRR (95% CI)
Meal pattern				
a) Breakfast intake frequency (n = 9064)				
Did not breakfast (n = 800)	0.53(0.40 – 0.72)**	0.54(0.42 – 0.71)**	0.59(0.45-0.77)**	0.66 (0.39 – 1.11)
7 days / week (n = 2787)	0.73(0.59 – 0.91)**	1.09 (0.89 – 1.32)	0.94 (0.77 – 1.15)	0.86 (0.60 – 1.24)
1 – 6 days / week (n = 5477)	1	1	1	1
b) Eating outside frequency (n = 9040)				
Never (n = 794)	0.76 (0.55 – 1.05)	0.71 (0.56 – 1.01)*	0.91 (0.68 – 1.22)	0.99 (0.58 – 1.70)
7 times / week (n = 319)	0.76 (0.47 – 1.20)	0.25 (0.41 – 0.94)*	0.72 (0.47 – 1.11)	1.43 (0.72 – 2.82)
4 – 6 times / week (n = 1112)	0.37 (0.65 – 1.17)	0.93 (0.72 – 1.20)	0.90 (0.69- 1.18)	1.39 (0.88 – 2.16)
1-3 times / week (n = 6815)	1	1	1	1
c) Snack food consumption (n = 9046)				
Never (n = 249)	0.79 (0.47 – 1.32)	0.64 (0.40 – 1.02)	0.67 (0.41 – 1.09)	0.99 (0.41 – 2.36)
7 times or more / week (n = 698)	0.77(0.53 – 1.11)	0.94 (0.67 – 1.29)	1.02 (0.74 – 1.42)	1.08 (0.59 – 1.98)
4 – 6 times / week (n = 2305)	0.74(0.59 – 0.93)**	0.91 (0.75 – 1.11)	0.94 (0.77 – 1.15)	1.35 (0.95 – 1.91)
1 – 3 times / week (n = 5811)	1	1	1	1

** Significant at p value < 0.001 * Significant at p value < 0.05

RRR: Relative Risk Ratio

Table 3: Factors Associated with VMS Prescription from Multivariate Multinomial Logistic Regression

	Doctor's instruction vs other unspecified Reasons RRR (95% CI)	Parent's advices other unspecified reasons RRR (95% CI)	Self-awareness vs other unspecified reasons RRR (95% CI)	Friends influence vs other unspecified reasons RRR (95% CI)
Gender (n = 9077)				
Boy (n = 4795)	0.90 (0.74 – 1.10)	0.70 (0.59 – 0.84)**	1.13 (0.94 – 1.35)	2.29 (1.60 – 3.29)**
Girl (n = 4282)	1	1	1	1
Strata (n = 9077)				
Urban (n = 5430)	0.95 (0.78 – 1.16)	1.40 (1.17 – 1.69)**	1.00 (0.84 – 1.21)	0.81 (0.58 – 1.13)
Rural (n = 3647)	1	1	1	1
Ethnicity (n = 9077)				
Malay (n = 6107)	0.54 (0.28 – 1.06)	0.76 (0.40 – 1.45)	0.84 (0.43 – 1.62)	1.30 (0.36 – 4.76)
Chinese (n = 1287)	0.41 (0.20 – 0.84)*	0.96 (0.49 – 1.89)	0.78 (0.39 – 1.56)	1.22 (0.31 – 4.78)
Indian (n = 544)	1.38 (0.63 – 3.03)	1.06 (0.49 – 2.24)	0.98 (0.45 – 2.11)	1.07 (0.23 – 4.94)
Bumiputra Sabah (n = 610)	0.69 (0.32 – 1.46)	0.79 (0.39 – 1.60)	0.73 (0.35 – 1.51)	1.31 (0.32 – 5.41)
Others (n = 215)	1	1	1	1
Height for age (n = 9070)				
Stunted (n = 786)	1.51 (1.11 – 2.10)*	1.09 (0.80 – 1.50)	0.96 (0.70 – 1.33)	0.72 (0.38 – 1.37)
Normal (n = 8281)	1	1	1	1
Experience of hunger (n = 9063)				
Never (n = 386)	1	1	1	1
Rare (n = 1867)	0.96 (0.76 – 1.20)	0.92 (0.75 – 1.12)	0.74 (0.49 – 1.13)	1.61 (1.10 – 2.35)*
Sometimes (n = 2655)	1.41 (1.08 – 1.85)*	1.26 (0.98 – 1.62)	1.38 (1.07 – 1.77)*	1.98 (1.27 – 3.08)**
Always (n = 4155)	0.81 (0.51 – 1.27)	0.79 (0.53 – 1.19)	0.74 (0.49 – 1.13)	1.50 (0.73 – 3.09)
Dietary behavior for the past month				
a) Vegetable intake at least three times daily (n = 9050)				
Do not eat three times daily (n = 5726)	1.08 (0.80 – 1.46)	1.13 (0.86 – 1.48)	1.16 (0.88 – 1.54)	1.16 (0.70 – 1.91)
Eat three times daily (n=3324)	1	1	1	1
b) Fruit and vegetables intake at least five times daily (n=9050)				
Not meet 2 serving fruit and 3 serving vegetable) (n=6773)	1.24 (0.89 – 1.73)	1.18 (0.87 – 1.59)	1.01 (0.75 – 1.38)	1.46 (0.82 – 2.58)
Meet 2 serving fruit and 3 serving vegetable) (n=2277)	1	1	1	1
c) Soft drink intake at least once a day (n=9050)				
Do not consume once a day (n=5515)	0.94 (0.77 – 1.15)	1.13 (0.94 – 1.35)	1.07 (0.89 – 1.29)	0.93 (0.67 – 1.30)
Consume at least once in a day (n=3535)	1	1	1	1
Meal pattern				
a) Breakfast intake frequency (n=9064)				
Did not take breakfast (n = 800)	0.53 (0.39 – 0.72)**	0.50 (0.38 – 0.66)**	0.59 (0.45 – 0.78)**	0.70 (0.41 – 1.18)
7 days / week (n=2787)	0.76 (0.61 – 0.96)*	1.08 (0.89 – 1.31)	0.96 (0.79 – 1.18)	0.91 (0.63 – 1.32)
1 – 6 days / week (n=5477)	1	1	1	1
b) Eating outside frequency (n=9040)				
Never (n=794)	0.74 (0.53 – 1.04)	0.75 (0.56 – 1.01)	0.95 (0.71 – 1.26)	1.04 (0.60 – 1.80)
7 times / week (n=319)	0.86 (0.53 – 1.39)	0.63 (0.41 – 0.97)*	0.72 (0.46 – 1.11)	1.43 (0.71 – 2.96)
4 – 6 times / week (n=1112)	0.95 (0.71 – 1.29)	0.80 (0.74 – 1.26)	0.92 (0.70- 1.21)	1.29 (0.82 – 2.05)
1-3 times / week (n=6815)	1	1	1	1
c) Snack food consumption (n=9046)				
Never (n=249)	0.93 (0.55 – 1.60)	0.66 (0.41 – 1.08)	0.70 (0.43 – 1.16)	0.99 (0.40 – 2.41)
7 times or more / week (n=698)	0.84 (0.57 – 1.23)	0.99 (0.71 – 1.38)	1.10 (0.78 – 1.55)	1.03 (0.54 – 1.94)
4 – 6 times / week (n=2305)	0.74 (0.59 – 0.93)	0.91 (0.74 – 1.11)	0.93 (0.76 – 1.14)	1.23 (0.85 – 1.76)
1 – 3 times / week (n=5811)	1	1	1	1

** Significant at p value < 0.001 * Significant at p value < 0.05

RRR: Relative Risk Ratio

In univariate multinomial logistic regression analysis, there was a significant correlation between adolescents who took fewer vegetables (do not eat vegetables three times daily) with doctor's instruction, parent's advice and friends' influence for VMS intake compared with other unspecified reasons. After adjustment, however, the association between vegetable intake and all the reasons for VMS intake was attenuated. As observed among adults, VMS intake was more prevalent in individuals who adopt healthier eating habits such as adequate consumption of fruits and vegetables (Mohd Ashri et al., 2021; Rautiainen et al., 2014). Contradicted to the belief that VMS intake was due to health consciousness behaviour, there were some studies that showed unhealthy dietary behaviour and VMS intake to compensate for an unhealthy diet (Benhusein & Taher, 2016). Consumption of soft drinks and fast food in this study, however, did not show a significant association with the reason for VMS intake. Based on this current finding, it was partly confirmed that the decisive factor of VMS intake in this study was not associated with adolescents' dietary behaviour.

Breakfast intake was significantly associated with the reason for VMS prescription even after multiple adjustments. VMS prescriptions by doctors, parents and due to self-awareness were less likely to be observed among adolescents who did not take breakfast compared with adolescents who took breakfast at least once a week. Most of the studies, including in Malaysia and Korea, claimed that VMS users were more likely to have breakfast regularly (Jeon et al., 2021; Mohd Ashri et al., 2021). Interestingly, adolescents in our study who skipped breakfast were less probable to consume VMS, which indicated that they were not aware of the consequences of skipping breakfast on nutrient deficiencies, or may be associated with other reasons which are not stated in the study. Furthermore, a recent Global Health Survey among Malaysian adolescents showed those who took breakfast at least once a week were mostly male, and non-stunted (Kim et al., 2016). This coincided with current findings, where male and non-stunted adolescents were least likely to be prescribed VMS due to their parent's advice, doctor's instruction and self-awareness compared with VMS intake due to other unspecified reasons.

In the final adjustment, adolescents who ate out 7 times per week were least likely to consume VMS due to parent's advice compared with other unspecified reasons. The possible justification was that the adolescents might not be staying together with their parents, for example, they were coming from boarding school, or due to other underlying reasons besides teen independence. Frequent eating out, energy-dense snack food and fast-food consumption among adolescents were evidence of high energy, fat and low micronutrient intake associated with a higher risk of overweight and obesity in adulthood (Almoraie et al., 2021; Gesteiro et al., 2022; Jia et al., 2022). No other significant association between meal pattern and reason for VMS intake was found.

To our knowledge, this is the first study that looked into the reasons for VMS intake and its association with dietary-related behaviour among adolescents. The strength of this study was due to nationally representative data, which makes our findings generalizable to the wider secondary school children population. However, this study was not without its limitation. The cross-sectional design in this study did not allow for an investigation of any causal relationship. A further limitation was the accuracy of dietary supplement intake obtained from self-reports by the participants, which was often impossible to determine.

5. CONCLUSIONS

In summary, this study revealed that VMS usage among adolescents was due to parent's advice, doctor's instruction, friends' influence and self-awareness. Gender, height for age, strata, ethnicity, hunger experience, eating out and breakfast intake frequency were associated with the reasons for VMS intake. Other dietary behaviour and meal patterns did not show significant associations with the reason for VMS intake. Based on these findings, a plan of action such as establishing and disseminating guidelines and nutrition education modules on VMS intake from the authority bodies from the Ministry of Health, Education, Communications and Multimedia targeting parents, students and the public should be prioritized to promote healthier dietary habits. The understanding of VMS intake versus taking healthy and natural forms of food should be the focus of lessons. Thus, there is a need to conduct further studies to look into the role of vitamin-mineral supplement use in relation to nutrient adequacy, overconsumption and health.

6. DECLARATIONS

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ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approvals of the study were obtained from the Medical Research and Ethics Committee (MREC), Ministry of Health Malaysia; Education Planning and Division (EPRD), Ministry of Education Malaysia prior to conducting the study. Informed written consent was taken from all respondents at the beginning of the study.

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