



Assessment of Dietary, Physical Activity and Sedentary Behaviours of Singapore Schooling Youths

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Abstract

Unhealthy lifestyle behaviors may set youths on the path to developing non-communicable diseases. Singapore schooling youths (n = 235, 67.2% female, age 17.5 (mean) ± 1.0 (SD) years) were recruited to examine the dietary, alcohol use, physical activity, and sedentary behaviors of the Singapore schooling youths. Demographic, anthropometric, and sedentary hours information were collected using structured questionnaires. Physical activity levels and dietary intakes, including alcohol use, were assessed using the validated International Physical Activity Questionnaire - long-form and localized food frequency questionnaire, respectively. The surveyed youths consumed significantly larger daily amounts of energy, sugar, saturated fat, and sodium than the levels recommended by the Singapore Health Promotion Board. They did not achieve the daily amounts of dietary fiber, fruits, and vegetables, and derived unhealthy proportions of daily energy from sugar and saturated fat. They did not exceed the recommended maximum daily alcohol allowance. Close to all the youths (91.2%) failed to adhere to more than five of the nine recommended healthy eating habits. Majority of these youths (73.4%) partook less than 600 MET-minute/ week. A significant number of the youths (38.1%) spent more than eight sedentary hours daily. Physical activity correlated significantly with sedentary behavior levels, but not the dietary scores. Most surveyed youths engaged in low physical activity and high sedentary behavior, and did not comply with most of the healthy eating guidelines proposed by the Singapore Health Promotion Board, specifically on daily energy, sugar, dietary fibers, saturated fat, sodium, and fruit and vegetable intakes.



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Introduction

Non-communicable diseases (NCD) account for approximately 71% of all global deaths each year according to the World Health Organisation (WHO).¹ Each year, 15 million people between the ages of 30 and 69 years die from NCD.¹ Cardiovascular diseases, cancers, respiratory diseases, and diabetes account for over 80% of all premature

NCD deaths.¹ An important way to control NCD is to reduce the associated modifiable behavioral risk factors, such as alcohol use, unhealthy diet, insufficient physical activity (PA), and high sedentary behaviors (SB).¹ As NCD impose huge economic costs on every societies,² investing in solutions to reduce the associated modifiable risk factors generates major financial gain to any society.²

Table 1: Dietary Guidelines set by the Singapore Health Promotion Board to adopt healthy eating habits.^{3,4}

| Nutrient | Guideline |
|---------------------|---|
| Energy | Consumes the appropriate amounts of calories, concerning the gender and age group as advised by the Singapore Health Promotion Board Female: 2040 kcal/ day ($\pm 10\%$) Male: 2700 kcal/day ($\pm 10\%$) |
| Carbohydrate | Obtains between 45% and 60% daily energy from carbohydrate |
| Sugar | Consumes no more than 55g sugar daily Derives no greater than 10% daily energy from sugar |
| Dietary Fibre | Meets the recommended dietary fibre intakes of 26 g/d for male and 20g/d for female youths |
| Protein | Obtains between 10% and 35% daily energy from protein Consume at least 60g protein daily for female youths and 80g protein daily for male youths |
| Fats | Obtains between 20% and 35% daily energy from fats Derives no greater than 10% daily energy from saturated fats |
| Sodium | Consumes no more than 2000 mg sodium daily |
| Fruit and vegetable | Consumes at least two servings of fruits and vegetables every day |
| Alcohol | Drinks no more than two (20g alcohol, female) or three (30g alcohol, male) standard drinks a day |

Dietary guidelines are useful to help people to eat healthily. The earlier editions of Singapore dietary guidelines were focused on nutrient-based recommendations. The current edition shifted its focus to food-based recommendations. This was in line with increasing recognition that food provides not only nutrients but also other non-nutrient compounds, such as phytochemicals, which appear to protect against chronic diseases. The current nine healthy eating habits for adult Singaporeans (age 18 to 69 years), published by the Singapore Health Promotion Board (SHPB), are summarised in Table 1.^{3,4} WHO recommends that an adult aged between 18 and 64 years old should do a minimum of 600 metabolic equivalents (MET) minutes of

total activity per week or about 150 minutes of moderate-intensity aerobic PA throughout the week or about 75 minutes of vigorous-intensity aerobic PA or an equivalent combination of moderate- and vigorous-intensity activity.⁵ For additional health benefits, the amounts of PA should be doubled.^{5,6} SB refers to any waking activity characterized by an energy expenditure less than 1.5 MET and a sitting or reclining posture.⁷ High SB (too much sitting) is now understood to increase the risk of major chronic diseases, and thereby reduce the quality of life.⁸⁻¹⁰ Increasing PA and reducing SB are among the recommendations of the WHO Global Strategy for Physical Activity to promote health and reduce NCD incidence.^{5,11}

Youths belong to a susceptible age group when they transit from adolescence to adulthood.¹² They start to spend more time outside their homes to develop their social and professional lives. Lifestyle behaviors, including dietary, alcohol uses, PA and SB adopted during the youth life stage are usually carried on to the adult stage.¹²⁻¹⁵ Unhealthy lifestyle behaviors may set these youths on the path to NCD, such as hypertension and type 2 diabetes in their adulthood.¹⁶⁻¹⁸ Therefore, it becomes important to identify and rectify the unhealthy lifestyle behaviors at the youth stage. There are limited data on the PA, SB, alcohol use, and dietary behaviors of the Singapore schooling youths. The study assessed the dietary behaviors, alcohol uses, and the levels of PA and SB adopted by the Singapore schooling youths. The same study also evaluated whether these lifestyle behaviors differ between the genders.

Materials and Methods

Study Design

The study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the Institutional Review Board, Nanyang Polytechnic (NYP IRB STUDY reference number SCL-2016-001). Healthy youths (aged 16-21), who were undertaking full-time schooling in Singapore, were recruited via word-of-mouth referral and poster advertisement from Nanyang Polytechnic. Informed consent was obtained from the participants. The age criterion of 16-21 years old was selected to capture the lifestyle behaviors of these susceptible age groups. The study excluded individuals who were clinically diagnosed with diabetes mellitus, hypertension, lipidemia, and other NCDs. A timeframe of 1 year starting from July 2018 was employed to recruit the participants. The demographic (age and gender), anthropometric (weight, height, body mass index, waist circumference, hip circumference, body fat mass, and lean body mass), dietary, PA, and SB assessments were conducted by trained technicians. The weight and height were measured using a calibrated weighing scale (Seca, Germany) and stadiometer (Seca, Germany), respectively. The body mass index (BMI) was computed by dividing the mass by the square of height. The waist and hip circumferences were measured using a measuring tape. The body fat and lean body masses were

determined using the bioelectrical impedance analyzer (Jawon ioi325, Korea).

Dietary Assessments

The dietary assessment evaluated quantitatively the specific macronutrient and micronutrient intakes and if the recruited youths adopted healthy eating guidelines as recommended by the SHPB (Table 1)c The healthy eating habits recommended by the SHPB apply generally to adults and should be applicable to the youths.^{3,4} Dietary intakes were assessed using a structured, quantitative, localized food frequency questionnaire (LFFQ). The same LFFQ was validated and used by the SHPB to examine the dietary intakes of Singapore residents, which were reported in the 2004 and 2010 Singapore Nutrition Surveys.^{19,20} The same localized FFQ was employed so that the results could be compared with those obtained in the past National Nutrition Surveys. The food composition database had been updated with local food and beverage items before the data from the LFFQ were analyzed using FoodWorks version 8 (Xyris, Australia) to obtain the nutrient composition (energy, fat, protein, carbohydrate, sugar, dietary fiber, cholesterol, sodium, fruits and vegetables, and alcohol) of the diets. Each youth was scored based on the number of healthy dietary guidelines fulfilled, with one point given for each guideline and a total of nine points from the nine guidelines (Table 1). In this study, the youths who scored five points and above were considered to be adopting healthy eating behaviors.

Physical Activity and Sedentary Behavior Assessments

The PA and SB levels were independently assessed using separate questionnaires. The validated International Physical Level Activity Questionnaire - long-form (IPAQ-L) was used to examine the PA levels of the participants. IPAQ-L is an instrument designed and validated primarily for population surveillance of PA among adults (age 15-69 years).²¹ It assesses PA undertaken across a comprehensive set of domains including leisure-time, domestic-related, work-related, and transport-related PA. The items are structured to provide separate domain-specific scores for walking, moderate-intensity and vigorous-intensity activity within PA domains. The volume of PA was presented as the metabolic equivalent of task (MET)-minutes/ week, which was

computed by multiplying the MET score of activity by the minutes performed in a week. The MET scores of vigorous, moderate, and low levels of PA were set as 10, 6, and 3, respectively. Participants were also classified as high PA levels (at least 3000 MET-minutes/ week), moderate PA level (between 600 and 3000 MET-minutes/ week), or low PA level (less than 600 MET-minutes/ week). The ranges of the PA levels were set with references to the WHO guidelines on physical activity¹¹ and Singapore National Physical Activity Guidelines.²²

The SB was examined by assessing the amount of sitting time. The youths were asked to think about the time they spent sitting at school, at home, while doing school work, and during leisure time. The youths were considered to engage in high SB for sitting 8 hours or more daily.⁹

Statistical Analyses

Statistical analyses were performed using SPSS version 26.0 (SPSS Inc., Chicago, IL, USA). Data were presented as mean \pm standard deviation (SD). Frequency analysis was performed using bin values set by the value ranges in the healthy dietary guidelines. Differences from specific values were analyzed using a one-sample t-test. Between-group differences for genders were analyzed using two-sample independent t-tests. Correlations were analyzed using Pearson's correlation tests. Statistical significance was set at $p < 0.05$.

Results

Youth Characteristics

Two hundred thirty-five youths (67.2% female, age 17.5 (mean) \pm 1.0 (SD) years) who were schooling at Nanyang Polytechnic at the time of recruitment (July 2018 – June 2019) were included in the study. Their demographic, anthropometric and dietary characteristics were presented in Table 2. The recruited youths were of healthy BMI (between 18.5 and 23 kg/m²). The male youths had significantly larger weight, height, BMI, waist and hip circumferences, and lean body masses than the female participants. The body fat masses did not differ significantly between the genders.

Dietary and Healthy Eating Behaviors

The youths consumed significantly greater daily amounts of energy than recommended by the SHPB

(Table 2). The male youths consumed significantly greater daily amounts of carbohydrates than their counterparts. Both genders derived between 45% and 60% of their daily energy from carbohydrates ($p < 0.05$ vs. 45% and $p < 0.05$ vs. 60% using one-sample t-tests, Table 2). The male and female youths consumed significantly greater amounts of sugar than the recommended daily maximum level ($p < 0.05$ vs. 55 g/d using one-sample t-tests, Table 2). The surveyed youths, regardless of gender, derived significantly greater than 10% of their daily energy intake from sugar and saturated fat separately ($p < 0.05$ vs. 10% using one-sample t-tests, Table 2). The male youths, on average, ate less than the recommended amount of dietary fibers ($p < 0.05$ vs. 26 g/d using a one-sample t-test, Table 2). The female counterparts achieved the recommended intake levels of the dietary fiber ($p < 0.05$ vs. 20 g/d using a one-sample t-test, Table 2). The male and female youths ingested significantly more proteins than their recommended daily requirement ($p < 0.05$ vs. 60g/d for female and 80g/d for male using a one-sample t-test, Table 2), but did not deviate from the recommended percentage of their daily energy deriving from the protein intake ($p < 0.05$ vs. 10% - 30% using a one-sample t-test, Table 2). There was also no significant difference in protein intake between the genders. The fat intakes and the percentage of daily energy derived from the fat intakes did not deviate from the recommended levels (Table 2). The mean daily sodium intake by the surveyed youths exceeded the recommended limits of 2000mg/d by 150% ($p < 0.05$ vs. 2000mg/d using a one-sample t-test, Table 2). The youths consumed significantly lesser than two servings of fruits and vegetables daily ($p < 0.05$ vs. 2 servings/d using one-sample t-tests, Table 2). The youths did not exceed the recommended daily alcohol intake limits ($p < 0.05$ vs. female, 2 standard drinks and male, 3 standard drinks using one-sample t-tests, Table 2). The specific nutrient intakes (except carbohydrates), total daily energy intakes and % daily energy derived from specific nutrients did not differ between the genders (Table 2). The anthropometric measures (weight, height, BMI, waist circumference, hip circumference, lean body mass, and body fat mass) did not correlate with the daily energy and specific nutrient intakes (results not shown).

Table 2: Characteristics, specific daily energy and nutrient intake (mean \pm SD) of the Singapore schooling youths (n=235) by gender and overall sample.

| | Overall (n=235) | Female (n=158) | Male (n=77) |
|---|------------------|------------------|---------------------|
| Characteristics | | | |
| Age (years) | 17.5 \pm 1.0 | 17.5 \pm 1.0 | 17.5 \pm 1.0 |
| Weight (kg) | 59.3 \pm 13.5 | 55.3 \pm 11.4 | 67.6 \pm 13.8** |
| Height (m) | 1.64 \pm 0.08 | 1.60 \pm 0.06 | 1.72 \pm 0.06** |
| Body Mass Index (kg m ⁻²) | 22.0 \pm 4.4* | 21.6 \pm 4.2* | 22.8 \pm 4.6*,** |
| Waist Circumference (cm) | 75.0 \pm 10.6 | 72.3 \pm 8.8 | 80.5 \pm 11.7** |
| Hip Circumference (cm) | 90.9 \pm 12.7 | 89.5 \pm 13.2 | 93.8 \pm 11.2** |
| Lean Body Mass (kg) | 44.7 \pm 8.5 | 40.2 \pm 5.0 | 53.9 \pm 6.9** |
| Body Fat Mass (kg) | 14.5 \pm 7.5 | 14.9 \pm 6.9 | 13.7 \pm 8.5 |
| Daily and specific nutrient intake | | | |
| Energy intake (kcal/d) | 2900 \pm 1370 | 2810 \pm 1400* | 3110 \pm 1290* |
| Carbohydrate (g/d) | 330 \pm 154 | 316 \pm 165 | 360 \pm 124** |
| % Daily energy from carbohydrate | 46.7 \pm 9.0* | 46.1 \pm 9.1* | 47.7 \pm 8.9* |
| Sugar (g/d) | 84.8 \pm 51.6* | 82.8 \pm 52.5* | 88.9 \pm 49.9* |
| % Daily energy from sugar | 11.9 \pm 4.9* | 11.4 \pm 4.4* | 12.1 \pm 5.2 * |
| Dietary Fibre (g/d) | 27.3 \pm 26.0 | 29.3 \pm 30.3* | 23.4 \pm 13.1 |
| Protein (g/d) | 152 \pm 86.2 | 148 \pm 86.6* | 161 \pm 85.3* |
| % Daily energy from protein | 20.5 \pm 4.5* | 20.6 \pm 4.4* | 20.3 \pm 4.6* |
| Fat (g/d) | 109 \pm 60.2 | 106 \pm 59.1 | 114 \pm 62.5 |
| % Daily energy from fat | 32.8 \pm 6.5* | 33.3 \pm 6.7* | 31.9 \pm 6.1* |
| Saturated Fat (g/d) | 39.8 \pm 22.2 | 38.3 \pm 22.0 | 42.9 \pm 22.3 |
| % Daily energy from saturated fat | 12.0 \pm 2.5* | 12.0 \pm 2.7* | 12.1 \pm 2.2* |
| Sodium (mg/d) | 4910 \pm 296* | 4920 \pm 3060* | 4900 \pm 2760* |
| Fruits (servings/d) | 1.08 \pm 0.78* | 1.06 \pm 0.75* | 1.12 \pm 0.84* |
| Vegetables (servings/d) | 1.43 \pm 0.83* | 1.44 \pm 0.80* | 1.42 \pm 0.89* |
| Alcohol (servings/d) | 0.17 \pm 0.61 | 0.22 \pm 0.70* | 0.08 \pm 0.32*,** |

* $p < 0.05$ vs lower (18.5 kg m⁻²) and upper (23.0 kg m⁻²) healthy Body Mass Index, recommended healthy eating habit level (female daily energy intake, 2040 kcal/d; male daily energy intake, 2700 kcal/d); minimum daily % energy from carbohydrate, 45%; maximum daily % energy from carbohydrate, 60%; maximum daily sugar intake, 55g/ d; maximum % energy from sugar, 10%; female daily dietary fibre intake, 20g/d; male daily dietary fibre intake, 26g/d; female daily protein intake, 60g/d; male daily protein intake, 80g/d; minimum daily % energy from protein, 10%; maximum daily % energy from protein, 35%; minimum daily % energy from fat, 20%; maximum daily % energy from fat, 35%; maximum daily % energy from saturated fat, 10%; maximum daily sodium intake, 2000mg/d; daily fruit intake, 2 servings/d; daily vegetable intake, 2 servings/ d; female daily alcohol intake, 2 servings/ d; and male daily alcohol intake, 3 servings/ d) using one-sample t-test.

** $p < 0.05$ vs the female participants using two-samples unpaired t-test.

Table 3: Descriptive and frequency statistics of the healthy eating habit scores of 235 Singapore schooling youths (n=235)

| Score | All (n=235) | Female (n=158) | Male (n=77) |
|---------------|------------------|------------------|------------------|
| Mean \pm SD | 3.35 \pm 0.88* | 3.37 \pm 0.86* | 3.32 \pm 0.92* |
| 1 point | 0.0% | 0.0% | 0.0% |
| 2 points | 14.5% | 12.7% | 18.2% |
| 3 points | 46.8% | 49.4% | 41.6% |
| 4 points | 29.4% | 27.8% | 32.5% |
| 5 points | 7.7% | 8.9% | 5.2% |
| 6 points | 1.7% | 1.3% | 2.6% |
| 7 points | 0.0% | 0.0% | 0.0% |
| 8 points | 0.0% | 0.0% | 0.0% |
| 9 points | 0.0% | 0.0% | 0.0% |

* $p < 0.05$ vs 5 points using one-sample t-test.

Table 4: Proportion (%) of the Singapore schooling youths (n=235) meeting the specific healthy eating habits set by the Singapore Health Promotion Board.

| Guideline | All (n=235) | Female (n=158) | Male (n=77) |
|--|-------------|----------------|-------------|
| Consumes the appropriate amounts of daily energy | 15.3% | 11.4% | 24.7% |
| Obtains between 45% and 60% daily energy from carbohydrate | 46.4% | 43.7% | 51.9% |
| Consumes no more than 55g sugar daily | 31.9% | 32.9% | 29.9% |
| Derives no greater than 10% daily energy from sugar | 41.7% | 41.8% | 41.6% |
| Consumes no more than 55g sugar daily and derives no greater than 10% daily energy from sugar | 0.0% | 0.0% | 0.0% |
| Meets the recommended dietary fibre intakes of 26 g/d for male and 20g/d for female | 47.2% | 55.1% | 31.2% |
| Obtains between 10% and 35% daily energy from protein | 99.6% | 99.4% | 100% |
| Consumes at least 60g protein/d for female and 80g protein/d for male | 89.4% | 89.9% | 88.3% |
| Obtains between 10% and 35% daily energy from protein, and consumes at least 60g protein/d for female and 80g protein/d for male | 88.9% | 89.2% | 88.3% |
| Obtains between 20% and 35% daily energy from fats | 61.3% | 59.5% | 64.9% |
| Derives no greater than 10% daily energy from saturated fats | 17.9% | 19.6% | 14.3% |
| Obtains between 20% and 35% daily energy from fats, and derives no greater than 10% daily energy from saturated fats | 14.5% | 15.2% | 13.0% |
| Consumes no more than 2000 mg sodium daily | 11.9% | 13.9% | 7.8% |
| Consumes at least two servings of fruits and vegetables every day | 14.0% | 13.3% | 15.6% |
| Drinks no more than two (20g alcohol, female) or three (30g alcohol, male) standard drinks a day | 97.0% | 95.6% | 100% |

The overall mean healthy eating score of the 235 youths, regardless of the genders, was significantly lower than 5 points (which was considered to be the passing score out of the total 9 possible points) ($p < 0.05$ vs. 5 points using one-sample t-tests, Table 3). None of the studied youths scored 7 points and above, and all had at least 2 points. 91.2% of them were considered not eating healthily as they did not score a minimum of 5 points. (Table 3). Significant proportions of females (88.6%) and male (75.3%) youths exceeded their gender-specific, daily recommended intakes of energy (Table 4). Of their daily energy intake, close to 50% of the surveyed youths obtained between 45% and 60% from carbohydrate, almost all between 10% and 35% from protein and nearly 60% between 20% and 35% from fat (Table 4). 45.9% and 7.7% of the youths derived less than 45% and more than 60% of their daily energy intakes from carbohydrates, respectively. 36.2% of the youths derived more than 35% of their daily energies from dietary fat. 89% of the surveyed youths attained the recommended daily protein intakes (Table 4). Sugar intakes made up greater than 10% of their daily energy intake among 58.3%

of the surveyed youths, with 69.1% of the surveyed youths (female, 67.1%; male, 70.1%) exceeding the recommended maximum level. None of the youths consumed a lower amount of sugar than the recommended amount, and derived less than 10% of their daily energies from sugar (Table 4). Slightly more than half the number of female youths and a lower proportion of male ones met the recommended gender-specific daily dietary fiber intake levels (Table 4). A majority of the youths (88.1%) exceeded their daily sodium allowance. Slightly less than one-sixth of the surveyed youths ate 2 or more servings of fruits and vegetables daily (Table 4).

Physical Activity and Sedentary Behavior

73.4% of the participants partook less than 600 MET-minutes/ week of physical activity and were classified as undertaking low PA (Table 5). 15.2% of the youths undertook moderate levels of PA, with slightly more than 10% engaged in high PA levels. Similar trends in PA levels were observed after gender stratification. The PA volumes did not differ between the genders (Table 5).

Table 5: Physical activity and sedentary behaviours of Singapore schooling youths (n=235) by gender and overall sample.

| | All (n=235) | Female (n=158) | Male (n=77) |
|---|----------------|-------------------|----------------|
| Physical activity | | | |
| Volume of physical activity (Metabolic Equivalent Task-minute / week) | 973±2220 | 1040±2320 | 876±2080 |
| Physical activity level (%) | | | |
| High | 11.4 | 12.0 | 10.4 |
| Moderate | 15.2 | 15.0 | 15.6 |
| Low | 73.4 | 73.0 | 74.0 |
| Sedentary behavior | | | |
| Total (hours/ week) | 49.3±22.0 | 48.5±22.1 | 50.3±21.9 |
| Weekdays (hours/ day) | 7.04±3.41 | 6.95±3.46 | 7.18±3.34 |
| Weekends (hours/ day) | 7.03±3.52 | 6.90±3.50 | 7.21±3.54 |
| High sedentary behavior level (%) | 38.1 | 37.6 | 38.7 |

* $p < 0.05$ vs. male participants using two-samples unpaired t-test.

Close to 40% of the youths sat more than eight hours daily and were considered to be engaged in high SB levels (Table 5). The SB behavior did not

differ between weekdays and weekends. The total weekly, weekdays and weekend SB hours did not differ between the genders (Table 5).

The healthy eating scores correlated neither with PA nor SB levels. The PA and SB levels correlated significantly before and after gender stratification (all, $r=-0.186$, $p<0.001$; female, $r=-0.211$, $p<0.001$; and male, $r=-0.140$, $p<0.05$).

Discussion

The relatively low mean healthy eating score suggested that the studied youths did not adhere to the healthy eating guidelines proposed by the SHPB, as supported by the low percentage of achieving or exceeding the passing score of 5 points. The youths, regardless of the genders, consumed significantly greater daily amounts of energy daily than recommended by the SHPB. Since 2004, Singaporean adults had been reported to consume more daily calories than the recommended levels.²⁰ The mean daily energy intakes of female and male youths observed in this study were comparatively lower than the respective values reported in the 2010 National Nutrition Survey (women, 2436 ± 70.2 kcal and men, 3302 ± 100.1 kcal).²⁰ The result agrees with the latest 2018 National Nutrition Survey which reported a 5% drop from the 2010 values.²³ The BMIs and other anthropometric measures of the studied youths were found to fall mostly within the healthy range and did not associate significantly with the daily energy intakes. These indicate the higher daily energy intake in these youths did not and/ or have not influenced their BMIs and other anthropometric measures. Alarming, a significant proportion of the youths acquired more than 10% of their daily energy from sugar, similar to the results of the previous National Nutrition Surveys.^{19,20,23} Concerns with the high levels of sugar consumption and its contributing calories, the SHPB had been advising the Singapore residents to consume lesser amounts of sugar, and recently announced the mandatory sugar-themed labeling, in addition to the sugar content stated on the nutrition information panel, for sugar-sweetened beverages to better communicate the level of sugar in these beverages to the consumers.^{24,25} This is in line with the general nutrition opinion that the sugar in these sugar-sweetened beverages offers only empty calories.²⁶

The youths consumed significantly more protein than the recommended levels from SHPB, though the energy derived from the protein did not exceed the healthy energy percentage of the total energy

contributed by protein. These had been reported in the previous National Nutrition Surveys.^{19,20} Given their low vegetable intakes, the youths were likely to obtain more of their protein from meat sources, rather than from plant-based ones. The higher fat intake result also agreed with the youths' preference for meat protein, as meat usually contains higher amounts of fat than plant-based food. The saturated fat over-consumption has been observed in the National surveys since 2010,²⁰ though the mean intake has begun to decrease,²³ and was likely due to the meat preference and poor choice of cooking oil and meat types.

Significant proportions of the youths, especially the male youths, did not satisfy the recommended daily dietary fiber intakes. The dietary fibre from the Asian diet was mostly derived from the fruits and vegetables. The reported low daily dietary fiber intakes could be explained by the daily consumption of less than the recommended two servings of fruits and vegetables. Singapore adults did not meet the recommended daily dietary fiber, fruits and vegetables (2 + 2 servings) intakes when the National Nutrition Surveys were conducted in 2004, 19 and 2010.²⁰ According to the press release of the 2018 National Nutrition Survey,²³ Singapore residents had increased their fruit and vegetable intakes compared to the consumption levels reported in 2004¹⁹ and 2010.²⁰ It did not, however, report if the increased fruit and vegetable consumption matched the levels recommended by the SHPB.²³ SHPB has been actively encouraging Singapore residents to consume at least two servings of fruits and vegetables daily.²⁷ In addition to dietary fiber, fruits and vegetables are excellent sources of essential vitamins, minerals, and phytonutrients.²⁸ The SHPB also encouraged Singapore residents to replace polished grains with whole grains, because of the latter's relatively higher dietary fiber content.²⁹

The surveyed youths did not consume alcoholic beverages beyond the healthy levels recommended by the SHPB. The observed result may be largely due to the prohibiting measures imposed by the Law of Singapore, which include a minimum age of alcoholic beverage purchase (18 years old),³⁰ and the shop hours allowed to sell alcoholic beverages (not after 10 pm daily).³¹ Nearly all the surveyed youths exceeded the healthy daily sodium intake

limit. The high sodium intakes were observed in the study despite the recent SHPB's health promotion campaigns against high salt intake.³² Probable reasons for the exceptionally high salt intakes include a high frequency of eating out, and high consumptions of sodium-laden fast food and processed food. Alarming, daily sodium intake among the Singapore residents was increasing over the years.^{19,20} The mean daily sodium intake reported in this study was more than double of the SHPB recommended maximum level. This is worrying as the over-consumption of sodium may result in NCDs, such as hypertension³³ and obesity.³⁴

Only slightly more than a quarter of the studied youths achieved moderate-to-high weekly PA levels. A lifestyle that includes regular PA has been associated with health benefits including reduced risk of obesity, type 2 diabetes mellitus, and coronary heart disease.³⁵ In a meta-analysis of 174 studies, higher levels of total PA were significantly associated with lower risks for breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke.⁶ The same analysis also reported that the major gains in risk lowering occurred at lower levels of activity, emphasizing the benefits of adopting moderate PA levels over lower ones.⁶ Conversely, one with low PA may be exposed to higher risks of NCDs.³⁶ Close to 75% of the surveyed youths did not achieve the minimum levels of PA (moderate PA levels) to maintain good health.²² This result agreed with another recent study by WHO examining the PA levels of adolescents (11-17 years old).³⁷ The study reported that 81.0% of youths (77.6% males and 84.7% females) aged 11 to 17 years from 146 countries were insufficiently physically active.³⁷ Physical inactivity behavior was found to follow youths into adulthood.³⁶ This means that these youths who were physically inactive would be physically inactive when they reach adulthood. Interventions are required to increase the PA levels of the youths before their physical inactivity results in permanent health damage. Five to ten minutes of running a day decrease the risk of cardiovascular disease by 45%.³⁸ The results of a systematic review and meta-analysis involving 3,439,874 participants to compare the association between PA and cardiovascular diseases/ type

2 diabetes mellitus suggested that the greatest gain in health were associated with moving from inactivity to small amounts of PA.³⁹ A more recent meta-analysis of 21 intervention studies (n=2042 intervention; n=2002 comparison group) concluded that chronic PA interventions had a significant small-to-moderate positive effect on cognitive function in youth when compared to no treatment.⁴⁰ Accordingly, SHPB has been actively advocating the importance of PA. Back in 2011, it launched the National PA Guidelines, which provided comprehensive PA recommendations for three groups of people: 19-49 years old, 50 years and above, and individuals who were seeking to prevent weight gain and obesity.²² Over the years, the SHPB, together with the Singapore Ministry of Health, have launched various programs to encourage Singapore residents to achieve the recommended PA levels.^{41,42}

Assuming eight hours of daily sleep, the youths surveyed in this study spent close to an equal number of hours on SB daily, regardless of weekdays or weekends. A recent systematic review and dose-response meta-analysis of³⁴ prospective studies involving 1,331,468 participants concluded that high SB was associated with all-cause, cardiovascular, and type 2 diabetes mellitus mortality.⁹ In another dose-response meta-analysis of 8 prospective studies involving 36,383 subjects, less time spent on SB was associated with reduced risks of premature death, especially among middle-aged and older adults.⁴³ Though it may not be surprising for this group of schooling youths to spend long hours sitting in classrooms during weekdays and academic activities during weekends, it becomes alarming when the high SB levels were observed simultaneously with low PA levels among these youths. There are currently no guidelines from health authorities and governments on the threshold daily SB period above which risks of health detrimental effects are increased. The Singapore National PA Guidelines recommend only to break out sedentary periods lasting longer than 90 minutes with 5 to 10 minutes of standing, moving around or doing some PA.²² More concerted efforts from the government and communities are required to encourage and motivate the youths to increase their PA and reduce their SB levels.

The strengths of the study lie in the simultaneous assessments of lifestyle (dietary, alcohol use, PA, and SB) behaviors on the same youth sample. The study did not observe gender differences across the PA and SB levels, alcohol use, and all of the dietary practices, except carbohydrate intake. The study did not evaluate the demographic and socio-economic factors influencing their PA, SB levels, alcohol use, and dietary behaviors. Future studies are required to elucidate these underlying factors. Unhealthy lifestyle behaviors of these youths will most certainly exert profound effects on their health in later life.¹⁶⁻¹⁸ These behaviors are formed predominantly during the growing-up years and are most certainly be carried over to the adult years.^{12,36} Compared to younger childhood and adolescent stages, youths can better understand the importance of healthy lifestyle behaviors, and their implications on health and well-beings.¹² Identifying and correcting unhealthy lifestyle behaviors in the youth life phase may prove to be more effective than intervening at a later life stage.¹²

Conclusion

Schooling youths in Singapore engaged in unhealthy lifestyle behaviors, like low PA levels, high SB, and unhealthy eating behaviors. While the SHPB should strategise its health promotion campaigns to emphasise the healthy lifestyle behaviors among the Singapore residents, specific data-informed policies and programs should be implemented to correct the identified unhealthy lifestyle behaviors among the youths.

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Conflict of Interest

The authors do not have any conflict of interest.

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