



## REVIEW

## Dietary assessment methods in surveillance systems targeted to adolescents: A review of the literature



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**Abstract** *Aims:* The present paper aims to identify ongoing multinational surveillance systems (SURSYSs) assessing diet and nutrition targeted to adolescents, including European surveys involving multiple countries and similar initiatives conducted in non-European countries with developed economies, and to describe the dietary assessment methods used.

*Data synthesis:* A total of 13 SURSYSs conducted in Europe, USA, Canada, Australia and New Zealand were identified. Dietary assessment methods commonly used include 24-h recalls (24H-Rs) and questionnaires or interviews. Food frequency questionnaires (FFQs) are used in combination with 24H-Rs in six SURSYSs: only FFQs are used in four SURSYSs; 24H-Rs only in one system and a 24H-R in combination with a general questionnaire/interview in one SURSYS. Eleven systems collect information also on some dietary habits and ten systems on other nutritional indicators such as anthropometric and/or biochemical measures. The FFQs used are not homogeneous and often include limited food or beverage items such as fruits and vegetables or sugar-sweetened beverages. In seven systems, foods specifically consumed by adolescents, such as fast food or snacks, are not assessed; instead, a total of seven systems collect data on supplement intake and just in very few cases on fats, legumes and/or water.

*Conclusions:* This study detected considerable variability across the systems identified, suggesting the need for a SURSYS targeted to adolescents that gathers as much as possible complete

**Abbreviations:** 24H-R, 24-h recall; AGENAS, National Agency for Regional Health Services that supports the Ministry of Health in Italy; AMPM, Automated Multiple-Pass Method; BKFS, Block Food Screener; BKQ, Block Kids Questionnaire; BMI, Body Mass Index; CAPI, Computer-Assisted Personal Interview; CATI, Computer-Assisted Telephone Interview; CCHS, Canadian Community Health Survey; CDC, Centers for Disease Control and Prevention; DEDIPAC, Determinants of Diet and Physical Activity; DEX, Decision Expert; EFSA, European Food Safety Authority; EHIS, European Health Interview Survey; FFQ, Food Frequency Questionnaire; FPQ, Food Propensity Questionnaire; GloboDiet initiative, Global Nutrition Surveillance initiative; HBSC, Health Behaviour in School-aged Children; IARC, International Agency for Research on Cancer; NCCOR, National Collaborative on Childhood Obesity Research; QL-FFQ, Qualitative Food Frequency Questionnaire; NHANES, National Health and Nutrition Examination Survey; NNPAS, National Nutrition and Physical Activity Survey; Nordic, Nordic monitoring of food, physical activity and overweight; NSLP, National School Lunch Program; NYPANS, National Youth Physical Activity and Nutrition Study; NZNS, New Zealand Nutrition Survey; Q-FFQ, Quantitative Food Frequency Questionnaire; SBP, School Program Breakfast Program; SFA, School Food Authorities; S-FFQ, Semi-Quantitative Food Frequency Questionnaire; SINU, Italian Society of Human Nutrition; SNDA, School Nutrition Dietary Assessment Study; SNMCS, School Nutrition and Meal Cost Study; SURSYS, Surveillance System; USDA, United States Department of Agriculture; WHO, World Health Organization; WWEIA, What We Eat in America; YRBSS/YRBS, Youth Risk Behaviour Surveillance System/Youth Risk Behaviour Survey.

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dietary information, with standardised methodology and regular periodicity. The detailed information provided by this review could be useful to national authorities for the choice of protocols to be applied in their own national surveys.

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## Introduction

Adolescence is a crucial period of development that begins at puberty and ends in early adulthood, with this age group representing almost a quarter of the global population [1,2]. Many disease and injury burdens in adolescents are preventable or treatable but are often neglected [3]; for instance, overweight and obesity in 2016 reached a worldwide prevalence of 18% among children and adolescents aged 5–19 years [4]. These diet-related disorders are often due to nutritional factors to which adolescents are exposed, such as poor diet diversity, low intake of nutrient-dense foods that support healthy diets, harmful alcohol consumption and sedentary lifestyle [5]; these factors have profound implications for the health status and well-being of future adult populations.

Therefore, collecting, monitoring and evaluating adolescents' dietary intake and habits should be priority actions within surveillance systems (SURSYSs) that need to be based on the careful choice of different dietary and non-dietary indicators of the community's nutritional status; these SURSYSs will conceivably guide nutritional policies and action plans [6,7].

The Italian Society of Human Nutrition (SINU), in collaboration with the National Agency for Regional Health Services (AGENAS), which supports the Ministry of Health in Italy, has launched the Project '*Health promotion in the third millennium: Facebook, social gaming and healthy lifestyles promotion among adolescents*'. One of the objectives of the project is to collect information about ongoing SURSYSs that involve multiple countries worldwide or more than one region/province/territory within a country and target adolescents as the population group. The identification and the description of SURSYSs on dietary intake and/or habits of the adolescent population will provide background information for the implementation of a national long-term SURSYS for monitoring health and nutritional status in Italy, which most likely will be applied in the different regions of Italy in such a way that the survey and results will be representative for these regions. The Italian SURSYS will be developed according to the priorities of the Italian National Prevention Plan (Piano Nazionale della Prevenzione) 2014–2019 [8], as also recommended by the World Health Organization (WHO) [9–11].

The aim of this review is to identify ongoing SURSYSs assessing diet and nutrition targeted to adolescents, involving multiple European countries and multiple non-

European countries or regions/provinces/territories within a country with developed economies and to provide details and discuss the used dietary assessment methods.

## Methods

### Literature review

A literature review on SURSYSs targeted to adolescents was conducted in February 2019. PubMed and Scopus databases were searched to retrieve articles published in the last 12 years (1 January 2007 to 6 February 2019). A combination of the following keywords was used: nutrition, nutritional, diet, dietary, consumption, dietary habits, dietary behaviours; surveillance, surveillance system, survey, questionnaire; adolescent, adolescence, child, young and youth. The search was limited to European countries and non-European countries with developed economies, that is Australia, Canada, Japan, New Zealand and the USA, as defined in the document of the world economic situation from the United Nations [12], and to English or Italian language articles. A screening of title and abstract was initially performed, which was followed by a detailed examination of selected full-text articles. In the case of any doubt, two investigators came to an agreement after analysis and discussion. Inclusion criteria were the following: surveys involving multiple European countries and multiple states or regions/provinces/territories within Australia, Canada, Japan, New Zealand and the USA; observational study design; target group including subjects aged 10–19 years belonging to the general population; surveys designed for assessing food intake or habits and surveys for continuative data collection currently ongoing or once-off surveys conducted in the last 15 years. Other papers were searched by manually consulting the references of the articles. Eligible articles were then transferred to Endnote® version X4.02, and duplicates were identified and excluded.

### Internet website search

Information was also collected through the Internet websites of official Institutions, such as ministries, governmental associations, international commissions, institutions in the field of nutrition (see [Supplementary Material 1](#)).

## Results

### Literature review

A total of 5628 articles were initially identified (4607 papers in the PubMed database and 1021 in Scopus). After removal of duplicates and an initial screening of title and abstract, 564 papers were obtained and included in the full-text examination; a total of 412 articles were further excluded, as they did not meet the inclusion criteria. A total number of 152 articles (including 1 review) were integrated in the final review (see flowchart and references in [Supplementary Material 2](#)).

### General characteristics

**Table 1** shows a summary of the main characteristics of the identified 13 SURSYSs currently ongoing in Europe, Australia, Canada, New Zealand and the USA on adolescents. Multinational systems have not been determined in Japan. The foods and beverages investigated are reported in **Table 2**. The main objectives and a detailed list of all the foods and beverages assessed are showed in [Supplementary Material 3](#); other diet- or lifestyle-related variables are listed and discussed in [Supplementary Material 4](#). All the described characteristics refer to the last survey/instrument available.

Five SURSYSs were identified for Europe: European Health Interview Survey (*EHIS*), EU Menu, Global Nutrition Surveillance initiative (*GloboDiet initiative*), Health Behaviours in School-aged Children (*HBSC*) and Nordic monitoring of food, physical activity and overweight (*Nordic*). Six SURSYSs were found for the USA: *HBSC*, National Health and Nutrition Examination Survey-What We Eat in America (*NHANES-WWEIA*), National Youth Physical Activity and Nutrition Study (*NYPANS*), *SnackTrack*, School Nutrition Dietary Assessment Study (*SNDA*), Youth Risk Behaviour Surveillance System/Youth Risk Behaviour Survey (*YRBSS/YRBS*). Two SURSYSs were found for Canada: *HBSC* and the Canadian Community Health Survey (*CCHS*). Two SURSYSs targeting adolescents were identified for Australia and New Zealand: the National Nutrition and Physical Activity Survey (*NNPAS*) and the New Zealand Nutrition Survey (*NZNS*), respectively.

*HBSC*, *NYPANS* and *YRBSS/YRBS* target solely adolescents, *SNDA* targets both children and adolescents and *EHIS* includes only population aged 15 years or more; the other systems include all age population groups (**Table 1**). *HBSC*, *NYPANS* and *YRBSS/YRBS* are conducted in school settings, whereas the other SURSYSs are community-based surveys (**Table 1**).

The time interval applied for the surveys is different; some of them were conducted at regular time intervals (*NHANES-WWEIA* and *CCHS-Annual Component* every year; *YRBSS/YRBS*, every two years; *HBSC*, every four years). Other surveys had no defined periodicity: *SNDA* (four surveys, *SNDA I* in 1991–1992, *SNDA II* in 1998–1999, *SNDA III* in 2004–2005 and *SNDA IV* in 2009–2010); *EHIS* (two surveys, *EHIS 1* in 2006–2009 and *EHIS 2* in

2014–2015); *Nordic* (two surveys in 2007–2009 and 2010–2011); *NZNS* (two surveys, in 1997 and 2008–2009); *CCHS-Nutrition* and *NYPANS* (only one survey in 2015 and 2010, respectively) and *NNPAS* (one survey in 2011–2012). With regard to *EU Menu*, EFSA is planning data collection in some European regions every year; however, these data are not made available online. For the *GloboDiet initiative*, the time interval varies across countries. Finally, for *SnackTrack*, the time interval is not available.

### Dietary assessment methods

As shown in **Table 1**, the methods used to assess the individual dietary intakes of adolescents are mainly FFQs and 24H-Rs. All the identified SURSYSs use questionnaires for the assessment of food intakes, except the *GloboDiet initiative* and the component *CCHS-Nutrition* that consider only 24H-Rs; six SURSYSs include both FFQ and 24H-R (*CCHS-Annual Component*, *EU Menu*, *NHANES-WWEIA*, *NNPAS*, *NYPANS* and *NZNS*), one system uses both a general questionnaire/interview and a 24H-Rs (*SNDA*) and four SURSYSs include only FFQs (*EHIS*, *HBSC*, *Nordic* and *YRBSS/YRBS*). A total of eleven SURSYSs also collect information of different dietary habits through the questionnaires (*CCHS-Annual Component* and *CCHS-Nutrition*, *EU Menu*, *GloboDiet*, *HBSC*, *NHANES-WWEIA*, *NNPAS*, *NYPANS*, *NZNS*, *SnackTrack*, *SNDA* and *YRBSS/YRBS*), and ten systems include other nutritional indicators such as anthropometric and/or biochemical measures (*CCHS-Annual Component* and *CCHS-Nutrition*, *EHIS*, *HBSC*, *NHANES-WWEIA*, *NNPAS*, *Nordic*, *NYPANS*, *NZNS*, *SNDA* and *YRBSS/YRBS*).

### Food frequency questionnaires

The administration mode is different across the systems, with four FFQs being self-administered (*HBSC*, *NHANES-WWEIA*, *NYPANS* and *YRBSS/YRBS*) and seven questionnaires using an interviewer-based administration method (*CCHS-Annual Component*, *EHIS*, *EU Menu*, *NNPAS*, *Nordic*, *NZNS* and *SNDA*). Among the latter, the face-to-face mode is found in six systems (*CCHS-Annual Component*, *EHIS*, *EU Menu*, *NNPAS*, *NZNS* and *SNDA*), while the telephone administration in three SURSYSs (*CCHS-Annual Component*, *Nordic* and *SNDA*).

Most FFQs are qualitative (QL-FFQ) (*EU Menu*, *HBSC*, the *BKQ* of the *NHANES-WWEIA*, *Nordic* and *YRBSS/YRBS*); *NYPANS* and *NZNS* include both QL-FFQ and semi-quantitative FFQ (S-FFQ), while three are only S-FFQ (*CCHS-Annual Component*, *EHIS* and *NNPAS*); one uses a quantitative questionnaire (Q-FFQ) (the *BKFS* of the *NHANES-WWEIA*). Portion sizes are assessed in nearly the same way in all systems, with household measures or standard units commonly used to support subjects with their responses; food model booklets were used in *CCHS*, *EU Menu*, *NNPAS*, *NZNS* and *SNDA*. All the identified FFQs use pre-coded frequency categories. The majority provide a single frequency scale with five to eight options ranging from 'never' to 'several times a day' (**Table 2**). *NNPAS* asks for the number of portions/day; *Nordic* assesses both the number of portions per day and/or per week with three

**Table 1** Main characteristics of the selected surveillance systems: reference institution, geographic area and country/region, years of activity, age group, dietary assessment methodology, dietary habits and other nutritional indicators investigated.

Surveillance system	Government Agency/institution	Geographic area	Countries/regions	Years of activity (periodicity)	Age group (years)	Dietary methodology	Mode of assessment	Dietary habits	Other nutritional indicators
CCHS (Canadian Community Health Survey)- Nutrition; CCHS- Annual Component	Statistics Canada and Public Health Agency of Canada	Canada	<b>10</b> (Newfoundland and Labrador, Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, British Columbia); 3 territories (Yukon, Northwest and Nunavut)	<b>CCHS-Nutrition:</b> 2015 ( <i>undefined</i> )	≥1	24H-R	AMPM 1st interview: Face-to-face (CAPI) 2nd interview <sup>[a]</sup> : Telephone (CATI) Portion size using household measures and food model booklet	<ul style="list-style-type: none"> <li>- Location of meals or snacks consumption</li> <li>- Restricting food choices/food groups</li> <li>- Following special diets</li> <li>- Discretionary salt<sup>[b]</sup></li> <li>- Supplemented foods</li> <li>- Dietary supplements<sup>[c]</sup></li> <li>- Restricting food choices/food groups</li> </ul>	Weight, height ( <i>self-reported</i> )
				<b>CCHS-Annual Component:</b> 2000/2001-present Last survey:2017 ( <i>every 2 years until 2005; every year since 2007</i> )	≥12	S-FFQ <sup>[d]</sup>	Telephone interview (CATI)	<ul style="list-style-type: none"> <li>- Restricting food choices/food groups</li> </ul>	Weight, height ( <i>measured</i> )
EHIS (European Health Interview Survey)	European Commission	Europe	<b>17</b> (2006: Austria and Estonia; 2007: Slovenia; 2008: Belgium, Bulgaria, Czech Republic, Cyprus, France, Latvia, Malta and Romania and 2009: Germany, Greece, Spain, Hungary, Poland and Slovak Republic for EHIS 2006–2009; all 28 EU members and Island, Norway and Turkey for EHIS 2013–2015)	2006/2009-present Last survey: 2013/2015 ( <i>undefined</i> )	≥15	S-FFQ	Face-to-face interview Portion size with handful or household measures or unit standard	<ul style="list-style-type: none"> <li>- Discretionary salt<sup>[b]</sup></li> <li>- Dietary supplements<sup>[c]</sup></li> </ul>	Weight, height ( <i>self-reported</i> )
EU Menu	EFSA	Europe	<b>14</b> (Greece, Netherlands, Belgium, France, Spain, Romania, Portugal, Cyprus, Latvia, Estonia, Austria, Hungary, Italy, Slovenia)	2009-present ( <i>every year in selected countries</i> )	3 months-74	24H-R	AMPM 1st interview: Face to face (CAPI) 2nd interview <sup>[a]</sup> : Telephone (CATI) Portion size using household measures and food model booklet	<ul style="list-style-type: none"> <li>- Discretionary salt<sup>[b]</sup></li> <li>- Use of spices</li> <li>- Dietary supplements<sup>[c]</sup></li> </ul>	N/A
					10–74	FPQ: QL-FFQ	Face-to-face interview		

GloboDiet initiative (Global Nutrition Surveillance initiative) Europe Consortium	IARC, WHO	Europe	7 (Austria, Belgium, France, Germany, Malta, the Netherlands, Switzerland)	Varies upon countries' decision	≥1	24H-R	Telephone or face-to-face interview using Globo Diet-Software Portion size using photos, shapes, or household measures or unit standard	<ul style="list-style-type: none"> <li>– Location of meals or snacks consumption</li> <li>– Following special diets</li> <li>– Food preparation and cooking practices</li> <li>– Dietary supplements<sup>[f]</sup></li> </ul>	Weight and height ( <i>self-reported</i> )
HBSC (Health Behaviours in School-aged Children)	NICHD, NIH, US Department of HHS, HRSA, WHO	USA	50 (New England (6), Middle Atlantic (3), East North Central (5), West North Central (7), South Atlantic (8), East South Central (4), West South Central (4), Mountain (8), Pacific (5))	1993/1994-present Last survey: 2017/2018 (every 4 years)	11,13,15	QL-FFQ	Self-administered	<ul style="list-style-type: none"> <li>– Frequency of break-fast consumption</li> <li>– Number of snacks/day</li> <li>– Frequency of family meals</li> <li>– Weight control practices</li> </ul>	Weight and height ( <i>self-reported</i> )
		Canada	14 (British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, Newfoundland and Labrador, Prince Edward Island, Yukon, Northwest Territories, Nunavut)	2013/2014-present Last survey: 2017/2018 (every 4 years)	11,13,15				
	WHO, Regional Investigators	Europe	42 (Albania, Armenia, Austria, Belgium (Flemish), Belgium (French), Bulgaria, Croatia, Denmark, Estonia, Finland, France, Wales, Germany, Greece, Greenland, England, Iceland, Israel, Italy, Latvia, Lithuania, Luxembourg, Macedonia, Malta, Moldova, Norway, Netherlands, Poland, Portugal, Czech Republic, Republic of Ireland, Slovak Republic, Romania, Russia, Scotland, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, Hungary)	1982 <sup>[g]</sup> -present Last survey: 2017/2018 (every 4 years)	11,13,15				

(continued on next page)

Table 1 (continued)

Surveillance system	Government Agency/institution	Geographic area	Countries/regions	Years of activity (periodicity)	Age group (years)	Dietary methodology	Mode of assessment	Dietary habits	Other nutritional indicators
NHANES-WWEIA (National Health and Nutrition Examination Survey – What We Eat in America)	National Center for Health Statistics of the CDC	USA	50 (New England (6), Middle Atlantic (3), East North Central (5), West North Central (7), South Atlantic (8), East South Central (4), West South Central (4), Mountain (8), Pacific (5))	1971/1974-present Last survey: 2017/2018 Continuous survey from 1999 (every year)	6 months-74	24H-R	AMPM 1st interview: Face-to-face (CAPI) 2nd interview: Telephone (CATI) Portion size with probes using 3-dimensional food models and USDA food model booklet	– Infant feeding practices – School lunches – Eating away from home – Intake of ready to eat foods – Reading nutrition information on foods – Discretionary salt [b] – Following special diets – Weight history and weight control practices – Dietary supplements <sup>[b]</sup>	Weight, height, waist circumference, triceps and subscapular skinfolds <sup>[1]</sup> (measured) Biochemical data (measured)
NNPAS (National Nutrition and Physical Activity Survey)	Australian Government (Department of Health)	Australia	8 (New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania, Northern Territory, Australian Capital Territory)	1995–present Last survey: 2011/2012 (undefined)	≥2	24H-R	AMPM 1st interview: Face-to-face (CAPI) 2nd interview: Telephone (CATI) Portion size using food model booklet Face-to-face interview (CAPI) Portion size using household measures or unit standard	– Food avoidance – Discretionary salt [b] – Iodised salt – Following special diets – Dietary supplements <sup>[1]</sup>	Weight, height, waist circumference (measured)
Nordic (Nordic monitoring of food, physical activity and overweight)	Nordic Council of Ministers	Europe	5 (Denmark, Sweden, Norway, Iceland, Finland)	2007/2009 Last survey: 2010/2011 (undefined)	Adults: 18–65 Children: 7–12	QL-FFQ <sup>[k]</sup>	Telephone interview (CATI)	N/A	Weight, height (self-reported by parents)

NYPANS (National Youth Physical Activity and Nutrition Study)	CDC	USA	47 (New England (6), Middle Atlantic (3), East North Central (5), West North Central (6), South Atlantic (8), East South Central (4), West South Central (4), Mountain (8), Pacific (3)) <sup>[l]</sup>	1991-present Last survey: 2010 (undefined)	14–17	24H-R  QL-FFQ S-FFQ	Telephone interview <sup>[a]</sup> Self-administered Portion size using household measures or unit standard	<ul style="list-style-type: none"> <li>– Frequency of breakfast, lunch, dinner, snacks and fast food consumption</li> <li>– Availability of foods/beverages at school or at home</li> <li>– Location of meals or snacks consumption</li> <li>– Weight-control practices</li> </ul>	Weight, height ( <i>measured</i> )
NZNS (New Zealand Nutrition Survey)	Ministry of Health	New Zealand	6 (Auckland, New Plymouth, Wellington, Nelson, Canterbury, Otago)	1997-present Last survey: 2002 on children, 2008/2009 on adults (undefined)	Children: 5–14 Adults: $\geq 15$	24H-R   QL-FFQ <sup>[k,m]</sup>	1st interview: Face-to-face (CAPI); 2nd interview <sup>[a]</sup> : Telephone (CATI) Portion size using household measures and food model booklet Face-to-face interview (CAPI)	<ul style="list-style-type: none"> <li>– Frequency of breakfast consumption</li> <li>– Foods and beverages consumed at school</li> <li>– Eating from the four major food groups</li> <li>– Food avoidance</li> <li>– Preparing food with minimal fat and salt</li> <li>– Iodised salt</li> <li>– Use of low-fat and low-salt products</li> <li>– Consumption of high-fat, high-sugar foods</li> <li>– Dietary supplements<sup>[n]</sup></li> </ul>	Weight, height, waist circumference, triceps and subscapular skinfolds <sup>[o]</sup> ( <i>measured</i> ) Biochemical parameters ( <i>measured</i> ) Blood pressure ( <i>measured</i> )
SnackTrack	The NPD Group, Inc.	USA	50 (New England (6), Middle Atlantic (3), East North Central (5), West North Central (7), South Atlantic (8), East South Central (4), West South Central (4), Mountain (8), Pacific (5))	2010-present Last survey: N/A (undefined)	$\geq 2$	Interviews/questionnaires	N/A	<ul style="list-style-type: none"> <li>– Frequency of snacks consumption</li> <li>– Location of meals or snacks consumption</li> <li>– Consumer activities while snacking</li> </ul>	N/A

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**Table 1** (continued)

Surveillance system	Government Agency/ institution	Geographic area	Countries/regions	Years of activity (periodicity)	Age group (years)	Dietary methodology	Mode of assessment	Dietary habits	Other nutritional indicators
SNDA (School Nutrition Dietary Assessment Study)	Food and Nutrition Service- USDA	USA	<b>50</b> (New England (6), Middle Atlantic (3), East North Central (5), West North Central (7), South Atlantic (8), East South Central (4), West South Central (4), Mountain (8), Pacific (5))	1991/1992-present Last survey: 2009–2010 <sup>[p]</sup> ( <i>undefined</i> )	3–17	24H-R  Interview/questionnaire Checklist Interview/questionnaire	AMPM 1st interview: Face-to-face (CAPI) 2nd interview <sup>[a]</sup> : Face-to-face (CAPI) (for students) Portion size using household measures and food model booklet Telephone interview (school director, food service manager) On-site observation Telephone or face-to-face interview (for parents) <sup>[r]</sup>	– Family and personal eating habits – Foods consumed during school day, times, and portion sizes – Access to vending machine – Dietary supplements [q]	Weight, height ( <i>measured</i> )
YRBSS/YRBS (Youth Risk Behaviour Surveillance System/ Youth Risk Behaviour Survey)	CDC, US Department of HHS	USA	<b>47</b> (New England (6), Middle Atlantic (3), East North Central (5), West North Central (6), South Atlantic (8), East South Central (4), West South Central (4), Mountain (8), Pacific (3)) <sup>[l]</sup>	1991–present Last survey: 2017 ( <i>every 2 years</i> )	12–17	QL-FFQ <sup>[k]</sup>	Self-administered	– Food avoidance (for allergic reactions) – Weight control practices	Weight, height ( <i>self-reported</i> )

In grey surveillance systems in school setting.

**Notes** [a] Among a subsample; [b] Include questions on: 1) The type of salt usually added to the food at the table and/or 2) How often salt is added to food at the table and/or 3) How often salt is added in cooking or preparing foods; [c] Vitamins and minerals; [d] The same S-FFQ was included also in the 2004 CCHS 2.2 survey; [e] Vitamins A, D, A/D, K, B, C, brewer's yeast, multivitamins without and with minerals, iron, calcium, fluoride, omega-3, fish oil; [f] Vitamin, mineral or oligoelement capsules; [g] UK, Norway, Finland at the beginning, afterwards the survey has been extended to include today 42 European Nations; [h] Vitamins, minerals, and non-vitamin-mineral (e.g. botanical supplements and amino acids); [i] In certain NHANES cycles, body composition data have been measured also using bioelectric impedance and DXA; [j] Vitamins, minerals, other natural and herbal supplements; [k] S-FFQ for some questions; [l] Oregon, Washington and Minnesota did not participate in 2015 survey; [m] S- FFQ for 2002 survey on children; [n] Multivitamins and multiminerals, single vitamin and/or single mineral, oil, other, bran, lecithin, LSA (linseed, sunflower and almond), Kelp, spirulina, glucosamine, and/or chondroitin, echinacea, ginkgo, hypericum (St John's Wort), sports supplement; [o] Triceps and subscapular skinfolds were measured only in 2002 National Children's Nutrition Survey; [p] The SNDA studies have been replaced by the School Nutrition and Meal Cost studies [SNMCS; last survey 2014–2015]; [q] List not available; [r] In previous surveys, this was also used as a questionnaire/interview for students.

**Abbreviations: Agencies:** CDC- Centers for Disease Control and Prevention; EFSA - European Food Safety Authority; HHS - US Department of Health and Human Services; HRSA- Health Resources and Services Administration; IARC - Agency for Research on Cancer; NCHS- National Center for Health Statistics; NICHD - National Institute of Child Health and Human Development; NIH - National Institutes of Health; USDA - US Department of Agriculture; WHO - World Health Organization. **Tools:** 24H-R - 24-h Dietary Recall; AMPM- Automated Multiple-Pass Method; BKFS - Block Kids Food Screener (2–17 years); BKQ - Block Kids Questionnaire (8–17 years); CAPI - Computer Assisted Personal Interview; CATI - Computer Assisted Telephone Interview; FFQ - Food Frequency Questionnaire; FPQ - Food Propensity Questionnaire; N/A - not available; QL-FFQ - Qualitative Food Frequency Questionnaire; Q-FFQ - Quantitative Food Frequency Questionnaire; S-FFQ - Semi-Quantitative Food Frequency Questionnaire; SPAN- School Physical Activity and Nutrition Project.

response options, and the number of times per day, per month and per week with four response options; *CCHS-Annual Component* evaluates frequency as the number of times per day, per week, per month with an open-ended frequency option.

Two FFQs are aimed to assessing the 'usual' intake without indicating a previous period of consumption (*EHIS* or *HBSC*), whereas most FFQs specify the time period to which the consumption frequency refers, generally the previous week (*NHANES-WWEIA* and *YRBSS/YRBS*), the previous month (*EU Menu* and *NZNS*), the previous month/week/day (*CCHS-Annual Component*), or the previous year (*Nordic*) (*Table 2*). However, some questionnaires use for different food items or even for the same food item both usual and a specific time period, such as the previous day (*NNPAS*) or both the previous week and the previous day (*NYPANS*).

The number of questions focussing on the intakes and other dietary habits ranges from a minimum of 3 to a maximum of 40 and are, in general, included as specific sections of very long questionnaires.

The number of questions on food/beverage consumptions ranges from 1 to 24, and the number of food/beverages assessed ranges from 3 to 39 (no data available for *SNDA* and *SnackTrack*). Some questionnaires evaluate only few aspects of the adolescents' diet: *NNPAS* that includes three questions only on fruit and vegetables and tap water consumption; *HBSC* with only four items (fruit, vegetables, sweets and soft drinks in the core questionnaire); *NHANES-WWEIA*, *Nordic* and *NZNS*, which are comprehensive in terms of items evaluated (*Table 2*).

All questionnaires that are being used in the identified systems assess fruit and vegetable consumption (*Table 2*); some of them use the general term 'fruit and vegetables' (*EHIS*, *Nordic*, *CCHS-Annual Component*, *NNPAS* and *NZNS*), while others include more detailed reporting such as raw vegetables/salads (*Nordic*, *NYPANS* and *YRBSS/YRBS*), cooked vegetables (*NHANES-WWEIA*, *Nordic* and *NYPANS*), non-fried potatoes (*CCHS-Annual Component*, *NHANES-WWEIA*, *NYPANS* and *YRBSS/YRBS*) and fried potatoes (*Nordic*, *NHANES-WWEIA*, *NYPANS* and *NZNS*). Only in one case (*NHANES-WWEIA BKFS*), legumes are assessed as a separate item, while in other systems, they are included under the general item 'vegetables' (*CCHS-Annual Component*, *EHIS*, *NZNS*), the item 'other vegetables' (*NYPANS*) or the item 'vegetables, pulses and/or root fruits' (*Nordic*).

*EHIS*, *HBSC*, *NHANES-WWEIA*, *Nordic* and *NZNS* assess the intake of sweets and only *EU Menu*, *Nordic* and *NZNS* evaluate the intake of oils/fats.

Eight systems assess beverages (*Table 2*), with seven of them referring to soft drinks and fruit juices: four out of these seven systems ask for 100% fruit juice intake (*CCHS-Annual Component*, *EHIS*, *NYPANS* and *YRBSS/YRBS*), three evaluate fruit juice intake in general (*NHANES-WWEIA*, *Nordic* and *NZNS*) and two assess also dietetic/light drinks (*Nordic* and *NYPANS*). Four questionnaires evaluate sports drink intake (*Nordic*, *NYPANS*, *NZNS* and *YRBSS/YRBS*), whereby *NYPANS* also include energy drinks as a separate item. Finally, data on water are collected only in two cases (*NNPAS* and *NYPANS*).

### **Twenty-four-hour recalls**

Among the eight SURSYSs that use the 24H-R method, all are computerised methods that are used through face-to-face (Computer Assisted Personal Interview – CAPI) and telephone interview (Computer Assisted Telephone Interview – CATI) (*Table 1*), and all are administered twice from three to ten days after the first interview, except *SNDA*, which is administered only once, and *GloboDiet* for which each country can decide on the number of recalls. One survey involves telephone interview only on a subsample (i.e. *SNDA*). A Food Model Booklet with pictures of various sizes of glasses, mugs, bowls, mounds/pats/spreads and circles is always used to help respondents describe the size or amount of food consumed.

### **Dietary habits**

With regard to dietary habits, information is collected through self-completed questionnaires or as part of the 24H-Rs. Breakfast consumption is considered in three SURSYSs (*HBSC*, *NYPANS* and *NZNS*), while dietary supplements are evaluated in seven systems (*CCHS-Nutrition*, *EU Menu*, *GloboDiet*, *NHANES-WWEIA*, *NNPAS*, *NZNS* and *SNDA*). The intake of discretionary salt is assessed in five systems (*CCHS-Nutrition*, *EU Menu*, *NHANES-WWEIA*, *NNPAS* and *NZNS*), and detailed information is gathered about snack consumption, such as location, number/day, frequency and type/brand in other five systems (*CCHS-Nutrition*, *GloboDiet*, *HBSC*, *NYPANS* and *SnackTrack*). In seven systems, the adoption of special diets or weight control practices is evaluated (*CCHS-Nutrition*, *GloboDiet*, *HBSC*, *NHANES-WWEIA*, *NNPAS*, *NYPANS* and *YRBSS/YRBS*) (*Table 1*).

### **Anthropometric measures**

Weight and height are measured in six SURSYSs (*CCHS-Nutrition*, *NHANES-WWEIA*, *NNPAS*, *NYPANS*, *NZNS* and *SNDA*) and self-reported in four (*CCHS-Annual Component*, *EHIS*, *HBSC*, *Nordic* and *YRBSS/YRBS*) (*Table 1*). Waist circumference is measured in three initiatives (*NHANES-WWEIA*, *NNPAS* and *NZNS*) and skinfold thickness in two surveillance systems (*NHANES-WWEIA* and *NZNS*) (*Table 1*).

### **Discussion**

This paper identified SURSYSs that collect dietary data on adolescents and examined their dietary assessment methods used. To our knowledge, this is the first overview of the international literature that includes and describes the key characteristics of worldwide multinational SURSYSs assessing dietary intakes and habits in adolescence, by applying a survey protocol in multiple countries or regions/provinces/territories within a country so that the results are representative for each region. We found only a recent review that reports on an inventory of European SURSYSs assessing dietary (beyond physical activity and sedentary) behaviours in Europe, with a focus on SURSYSs, but it comprises only European countries and populations

**Table 2** Food questions (number), frequency options (number), intake reference period and foods and beverages included in the questionnaires used in the last available survey of the selected surveillance systems<sup>a</sup>.

	Food questions (n)	Frequency options (n)	Intake reference period	Food/Beverage (n)	Foods			
					Fruit	Vegetables	Potatoes	Cereals and derivatives
CCHS-Annual Component	6 <sup>(a)</sup>	Open	Last month, week, day	6 (5 foods, 1 beverage)	1 [1]	3 [4]	1	
EHIS	11	5	Last week	10 (8 foods, 2 beverages)	1	1 [4]		
EU Menu	1	8	Last month	20 (20 foods)	2 [2]	3		1 [10]
HBSC	4	7	Usual	4 (3 foods, 1 beverage)	1	1		
NHANES – WWEIA	4 (BKFS)	6	Last week	39 (37 foods, 2 beverages)	3	7 [5]	2 [8]	4
NNPAS	3	8	Usual	3 (2 foods, 1 beverage)	1 [1]	1		
Nordic	15	3 or 4	Usual	31 (27 foods, 4 beverages)	2	3 [6]	3 [9]	4 [11]
NYPANS	24	6 or 7	Last week and previous day	16 (8 foods, 8 beverages)	1 [1]	3 [1,7]	1 [8]	
NZNS	24 <sup>(b)</sup>	7	Last month and usual	19 (16 foods, 3 beverages)	1 [3]	1 [3,4]	2	1 [11]
YRBSS/YRBS	10	7	Last week	10 (6 foods, 4 beverages)	1	3	1	

**Notes:** [1] Frozen, canned or dried included; [2] Only dried fruit; [3] Frozen, canned or stewed included; [4] Legumes included under the general item “vegetables”; [5] Legumes included as a separate item; [6] Legumes included as “vegetables, pulses and/or root fruits”; [7] Legumes included as “other vegetables”; [8] Fried potatoes included; [9] Only fried potatoes; [10] Only breakfast cereals; [11] Rye, white, whole-grain and hard bread; [12] Only smoked cheese; [13] Full-fat cheese; [14] Flavoured milk included; [15] Also processed meat; [16] Only smoked sausages and offal; [17] Shellfish as a separate item; [18] Smoked fish, fatty fishes, clams, oysters, mussels, scallops as separate items; [19] Shellfish included; [20] Fried, canned and fresh frozen as separate items; [21] Only nut spread; [22] Fats used on the bread (butter, oil-butter spreads, vegetable margarine 60–80%, low-fat margarine, “BeceL Pro-Active”, margarine 70–80%, fat – pig/duck/coconut) and fats used to fry, cook, paste (butter, oil-butter spreads, frying or baking margarine 70–80% fat, vegetable margarine 60–80%, fluid margarine/oil margarine, oil, mixture of oil and butter/butter oil spreads, fat – pig/duck/coconut); [23] Type of butter/margarine spread; type of fat/oil; low/reduced fat varieties of foods; [24] Only not 100% fruit/vegetable juices; [25] Sweet/carbonated soda; [26] Dietetic/light soda; [27] Energy drinks included; [28] Energy drinks as a separate item.

<sup>a</sup> *GloboDiet initiative, SnackTrack and SNDA* are not listed because a FFQ was not included in the system or available for consultation; (a) the same questions were included also in the 2004 CCHS 2.2 survey; (b) 2002 survey for children is composed by 117 questions (101 foods and 16 beverages, ice blocks included).

of all ages [13]. Another review focused on the methods used to assess intake of fruits and vegetables only among European adults and children [14].

A total of 13 different ongoing systems at the international level were retrieved through the present literature search, with wide heterogeneity among systems found in target population, setting, periodicity and assessment methodology.

Among the three school-based surveys addressing solely adolescents, *HBSC* is a multi-objective survey on health and wellness that is not specifically and exclusively envisaged for dietary and nutritional data collection (only 5 nutritional items are assessed in the core questionnaire). *NYPANS* and *YRBSS/YRBS* are more detailed for assessing nutritional aspects of adolescents, through the evaluation of 16 and 10 food/beverage items, respectively. As a general comment, when a country is planning a dietary survey among adolescents using an existing instrument such as one of those mentioned, the chosen instrument should then refer to the same concept or the area of study envisaged [15]. Conversely, community surveys such as *NHANES-WWEIA*, *Nordic* and *NZNS* consider even a higher number of food items, thus providing a more dietary-centred monitoring system on adolescents.

Surveillance involves repeated data collection with reasonable frequency and is often used to build policies and evaluate the effectiveness of preventive interventions

[16]. A high variability in periodicity was found among the SURSYSs identified; only three systems are conducted with regular frequency, while the others are carried out without any defined time interval; this limits the possibility of comparing situations and trends across countries. Nutrition policies in Europe, USA, Australia and New Zealand refer to a time frame of five to ten years [17–21]. Canada's strategy does not have a time frame, as a food policy is underway (<https://www.canada.ca/en/health-canada/services/publications/food-nutrition/healthy-eating-strategy.html>). Hence, it would make sense that dietary surveys are conducted with a reasonable time interval, for example, three to five years as recommended by the WHO for diet-related indicators [22,23], to monitor the implementation and results of these policies; in fact, a too long period does not allow a continuous and effective monitoring.

Our results also show diversity in the methods used to assess individual dietary intakes of adolescents, with FFQ and 24H-R being the two mainly used retrospective direct methods. These methods often apply to different time frames, thereby resulting in a wide variance in both the quality and the quantity of available data and making comparisons difficult within and between countries; moreover, in most systems, FFQs are not homogeneous, as they have been frequently modified in subsequent waves of the survey, which makes comparisons even more difficult.

Foods									Beverages			
Milk and derivatives	Meat and derivatives	Fish	Fast food	Snack foods, Pizza, sandwiches	Eggs	Fat types	Sweets (including cakes, candies, ice cream)	Water	100% Fruit/vegetable juice	Soft drinks	Sports drinks	
									1			
1 [12]	3 [15] 4 [16]	1 8 [17,18]				1 [21]	2			2 [25,26]		
2	5	1 [19]	6	3	1		1 3		1 [24]	1 [25] 1 [25]		
1 [13]	1 [15]	1 [19]				8 [22]	4	1	1 [24]	2 [25,26]	1 [27]	
1			1	1				1	1	4 [25,26]	2 [28]	
1 [14]	3 [15]	2 [19,20]	1	1		2 [23]	1		1 [24]	1 [25]	1 [27]	
1								1	1	1 [25]	1	

The selection of a dietary assessment method for a national dietary surveillance systems depends on nutrition information to be collected [24] and policy objectives to be achieved [15]. When estimates of the absolute mean ‘usual’ intake of a population group are crucial, and individual usual intake has to be assessed, and then detailed intake information should be collected by a 24H-R, which is the preferable method for adolescents compared to a record method, on at least two (preferably non-consecutive) days for each individual. Actually, the 24H-R was administered twice in most systems. A FFQ is the preferred tool when individual means of the usual food intake are crucial for linking diet changes to health and disease risk, although the number and type of foods included in the FFQ influence the accuracy and representativeness of the results [15].

Both instruments have critical aspects that should be taken into account when implementing a SURSYS targeted to adolescents. Children consume foods with frequencies and quantities that are not necessarily constant over time, and it is most unlikely that they pay attention to these issues when they are eating [25]. Adolescents have rapidly changing and less structured dietary habits than children (e.g. snacks, meal skipping), and they frequently eat outside the home [26]. Finally, it is noteworthy that children and adolescents often perceive interviews or self-administered questionnaires as long and boring; the use of new technologies is contributing to the development of

new tools adapting dietary assessment methods to their cognitive abilities [26].

A food atlas with photographs to quantify the portion sizes is used only in *NHANES-WWEIA* and *GloboDiet*, which means that the accuracy of the portion sizes of certain foods estimated in the other SURSYSs may be limited.

The number of items assessed varies among the identified systems, with priorities directed to foods and beverages such as fruits and vegetables, potatoes and sugar-sweetened beverages. All systems assess fruit and vegetable intake, but there is no agreed understanding of ‘fruit’ or ‘vegetable’ in terms of how they should be captured through dietary assessment methods, and the definition of what constitutes a fruit or vegetable can often hinder meaningful comparisons; this may create issues when measuring and tracking intake across different regions [14].

In spite of the role of the omega essential fatty acids in the prevention of different disorders including cardiovascular diseases, only *EU Menu* collects detailed information of the intake of dried fruit, and other three systems include dried fruit within the questions on general fruit consumption. Similarly, the consumption of fish is assessed only in four FFQs (*EU Menu*, *NHANES-WWEIA*, *Nordic* and *NZNS*), with just the *EU Menu* including the fatty fishes as a separate item.

In more than half of the systems, foods specifically consumed by adolescents, such as ‘fast’ food or sweet

snacks or savoury snacks that are high in fat, sugar and/or salt, are not assessed, although they may be a major part of their diet [27]. Similarly, knowing that the consumption of energy drinks among adolescents has become a popular behaviour, which has implications for different cardiovascular events, their inclusion in the FFQ would be worthwhile to consider [28].

It is noteworthy that assessment of food/beverage items often differs between countries due to local habits, as well as definitions and terms used or the incorporation of some items within a wider food group (e.g. dried fruit often included in the fruit item; legumes included in the vegetables item; energy drinks and sports drinks sometime overlapping).

Among dietary habits, the frequency and definition of breakfast are assessed differently: *HBSC* defines breakfast as the consumption of more than a cup of milk, tea or fruit juice, while *NYPANS* and *NZNS* do not provide any qualitative indication. Consumption of supplements is evaluated quite frequently, and this aspect is important, as the intake of nutrients from supplements can make substantial contributions to total intakes [29]. In the selected systems, salt intake is evaluated only as added salt, and only one system (*NHANES-WWEIA*) considers the adherence to the reference standards. Moreover, none of the *SURSYS*s considered aimed at assessing adherence to the Mediterranean Diet, despite a recent meta-analysis stating that greater adherence to a Mediterranean diet is associated with a significant improvement in health status and proposing a literature-based adherence score that can be used to assess adherence to the Mediterranean diet at epidemiological and individual levels [30]. This piece of information could be clinically relevant for public health, in particular for encouraging a Mediterranean-like dietary pattern since adolescence for primary prevention of major chronic diseases.

After the food intakes, the most assessed aspects are weight and height, which are self-reported only in four systems. The collection of measured instead of self-reported anthropometric data increases the accuracy of the obtained information [31], as well as the assessment of body circumferences and skinfold thicknesses, even though the use of skinfold thicknesses requires high standardisation and experience to achieve precise measurement [32,33].

Because of the restrictions introduced in the search strategy, for example, publication language, publication year and search engines, the review could not be as comprehensive as expected. For instance, the search strategy was limited to English—or Italian-language papers only, so that existing *SURSYS*s published in other languages might not have been included, which then could have introduced a selection bias [34]. Moreover, only papers published in the last 12 years were searched to be certain that information was collected on recent *SURSYS*s that may already have experienced at least one round of data collection or that are currently running.

Another limitation of the study is that, as the present search was targeted only to countries with developed economies, Japan was the only country included in the Asian continent. Asian countries have several nutritional

issues and different specific food/nutrient assessment needs; for example, Cambodia, Mongolia, Nepal, Pakistan and Vietnam reflect higher interest in assessing under-nutrition and micronutrient deficiencies, while nutrition surveys in China, Japan, Singapore and South Korea focus on the assessment of nutrition intake adequacy for all individuals and prevalence of chronic diseases such as obesity [35]. Thus, thus far, multinational systems have not been identified in Asian countries, and only systems providing information about nutrition-related surveys at the 'national' level are present; in Japan, the National Health and Nutrition Survey is conducted every year by the National Institute of Health and Nutrition [36,37].

The authors believe that the present study provides an exhaustive overview of ongoing multinational surveillance systems in the field of food and nutrition to guide all interested stakeholders in conceiving a surveillance system that can allow comparison of data at the international level. Beyond the heterogeneity of dietary assessment methods found across the different identified systems, information provided by this review could be useful to national authorities for the choice of protocols to be used in their own national or local surveys. Although the 'ideal' dietary *SURSYS* targeted to adolescents is difficult to conceive, an approach contemplating accuracy [24] and sustainability of the system is encouraged; because of the different tools used to collect food/nutrition information of adolescents, an effort should be addressed towards an approach that makes data comparable between countries or regions/provinces/territories of a country. We believe that an effective multinational *SURSYS* could be built, after adequate adaptation to the adolescent age, along the lines of the WHO European Childhood Obesity Surveillance Initiative (COSI), a standardised, harmonised and systematic system running since 2007 that monitors obesity and other aspects such as eating habits [38].

In conclusion, the general framework of *SURSYS*s assessing dietary data targeted to adolescents is quite promising, as there are numerous ongoing activities, but harmonisation of methodology, a more food-focused assessment tool and more regular and continuous surveys are still needed to implement an accurate and sustainable nutritional surveillance system allowing data comparability across countries. This inventory will contribute to the identification of needs and gaps in this area to guide the design and implementation of improved dietary multinational systems to evaluate nutritional prevention strategies suitable for adolescents.

### Contributorship statement

GT performed the literature search and analyses and wrote the manuscript. FG helped in data analyses and in the preparation of the manuscript. TW critically reviewed the manuscript and contributed to a final draft of the manuscript. GC helped in manuscript preparation, critically reviewed the manuscript, helped in data interpretation and had primary responsibility for the final content. All authors read and approved the final manuscript.

## Competing interests

All authors declare that they have no competing interests. The findings and conclusions in this report are those of the authors, and the authors alone are responsible for the views expressed in this publication. They do not necessarily represent the official views or positions of their supporting companies or the Food and Agriculture Organization of the United Nations.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.numecd.2019.03.013>.

## Appendix

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