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D7.3 A system dynamic model (knowledge repository)

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Executive Summary

This report presents the documentation of a system dynamics computer simulation model as a part of the demonstrator which is a research component of the CO-CREATE project: Work Package 7 (WP7) *Evaluation of Co-Created Policy Interventions and the Methodology* led by the University of Oslo (UoO). Deliverable 7.3 is tasked to develop an adaptable system dynamic core model (knowledge repository). Thus, the system dynamics (SD) method was applied to integrate previous work packages results and other sources and to conduct a series of simulation experiments to understand the major feedback mechanisms driving youth obesity. The structure of the model was informed by Deliverable 7.1 *a review of existing system dynamics models and other systems approaches to childhood obesity*, an integrated system map drawing on all the system maps generated in Deliverable 4.2 from WP4, relevant literature on childhood and adolescence obesity research and expert workshops. The model was quantified using parameter values from the literature, expert knowledge elicitation and from the Health Behaviour in School-aged Children (HBSC) study. This report describes the model in detail. Model analysis and results will be reported in two scientific articles, as part of CO-CREATE supplement 2. The model is made available on 31.01.2023.

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List of Acronyms / Abbreviations

AdOWOB – Adolescent Overweight and Obesity

BE – Built Environment

BMI – Body Mass Index

BW – Body Weight

EBRB – Energy Balance Related Behaviours

FAO – Food and Agriculture Organization

FFM – Fat Free Mass

FM – Fat Mass

HBSC – Health Behaviour in School-aged Children

HN – High Nutritious

INIT – Initial

LN – Low Nutritious

PA – Physical Activity

PAL – Physical Activity Level

POBI – Pressure on Body Image

PPBOI – Perceived Pressure on Body Image

RCT – Randomized Control Trial

SD – System Dynamics

SE – Self Esteem

UoB – University of Bergen

UoO – University of Oslo

WHO – World Health Organization

WP – Work Package

Deliverable Description and Objective

According to the framework of Objective 7.1 *To develop an adaptable system dynamics (SD) core model (knowledge repository) for quantitative modelling of the system structure governing the development of obesity and the model-based assessment of selected policies, - both based upon state-of the art evidence (WP3) and the system maps (WP4*), and the corresponding Task 7.1. *To develop an adaptable SD core model (knowledge repository)*, the preliminary approach for WP7 was to develop a single SD model, which would serve as a knowledge repository as well as be used to simulate the direct and indirect, short- and long-term consequences of 1-3 of the most suggested co-created policies. While completing Objective 7.1 and related Task 7.1, we studied different methodologies that use SD in public health research, as well as their strengths and drawbacks based on each model's aim and available evidence and data. In this process, we discovered that adopting a single SD model to act as both a knowledge repository and a tool for simulation and assessment of policy effects was not the best approach for our modelling work. We discovered we could enhance the quality of D7.2 *Articles of simulation of policy effects.* and D7.3 *An SD model (knowledge repository).* by applying the SD method to each deliverable in a different way. As a result, we completed the simulation of policy effects component of Objective 7.1 by constructing a second - smaller - SD model designed exclusively for policy simulation and analyses to achieve D7.2.

The SD model in D7.3 captures and formalizes, at a population level, the feedback mechanisms responsible for adolescent overweight and obesity trends. It provides a basis for understanding the dynamic interplay between physiology and environmental variables such as food environment, physical activity environment, as well as mental well-being, and their effect on adolescent overweight and obesity (AdOWOB). The model integrates qualitative and quantitative data that has been collected in different CO-CREATE work packages and triangulates them with stakeholder group sessions for structural validation and parameter estimation, and statistical data for model behaviour analysis and validation.

This deliverable provides a documentation of the system dynamics (SD) computer simulation model developed in WP7. The model is based on D7.1 A systematic review on existing system dynamics models on overweight and obesity in children and adolescents and previous systems approaches to childhood obesity, a master system map drawing on all the system maps made in D4.2 in WP4 (also D4.6 *Country and master maps* and D4.5 *Structures for modelling*), a translation of the consensus map into a stock and flow diagram, and quantification of the diagram. Moreover, from the policy briefs generated in Deliverable 5.3 *CO-CREATE youth alliances' policy briefs*, five policies were selected and incorporated in the model to conduct sensitivity and scenario analyses. The model serves as a knowledge repository in that it integrates previous work packages results and other sources. The model can be used to conduct a series of simulation experiments to understand the major feedback mechanisms driving youth obesity.

SD model Purpose

The model was built to be used as an environment for exploring the behaviour resulting from the dynamic interplay of the feedback mechanisms governing youth obesity. The model allows to conduct simulation experiments where short- and long-term impact of youth-generated policy ideas can be explored. The focus of the model simulations is on the insights that tell feedback stories that can be used to identify leverage points to intervene in the system and change the direction and dominance of the feedback loops driving AdOWOB. Lastly, this model can be used as a tool to encourage broad discussions on AdOWOB prevention among diverse stakeholders from a systems perspective.

Model Overview

A population-level SD computer model that integrates the processes of human metabolism, body composition, food environment, physical activity environment, and mental well-being, is presented in this section. These processes are not independent of one another, and the model captures the complex interdependencies between them in the regulation of body weight and energy dynamics, and the environment. The work demonstrates how such an integrative simulation model can serve as a virtual laboratory for controlled experimentation to investigate the impacts of physical activity, diet, and mental health factors on energy-balance-related behaviours (EBRB). The model captures the dynamics of AdOWOB at a population level focusing on the interaction of different sub-models namely: *Population Weight Change Dynamics, Food Environment, Physical Activity (PA) Environment*, and *Mental Wellbeing.*

Model Assumptions

This is a population-level model that does not account for individual behaviours within each sub-system. The model is not meant for prediction, instead it operates at a higher level of aggregation. What we lose by giving up individual behaviours is the fine grain nuance of tracking specific people but the problem we are studying is one that plays out a population level. But what we gain by this aggregation level is the ability to explain why, from a feedback perspective, AdOWOB arises and persists over time. This aggregation level also allows us to run our model in seconds.

Model's Array[1] Dimensions:

- **Age groups:** 11-, 13- and 15-year-old.
- **Body Mass Index (BMI) categories:** normal weight, overweight and obese.
- **Gender**: male and female.
- **Food categories:** High Nutritious and Low Nutritious food.

[1] Arrays provide a powerful mechanism for managing visual complexity of the model structure. By 'encapsulating' parallel model structures, arrays can help in presenting the essence of a situation in a simple diagram. Though, behind the scenes, arrays retain the richness of the disaggregated structure (Isee Systems, 2022, tit. Working with Arrays)

Overview of Data

In this model both qualitative and quantitative data is used. For qualitative data, the model integrates the data collected in different Co-Create work packages (Deliverable 4.1 *Obesity systems maps,* Deliverable 4.6 *Country and master maps* and Deliverable 4.5 *Structures for modelling, and* Deliverable 5.3 *CO-CREATE youth alliances' policy briefs)* and uses system maps which have been built through collective work between adolescents (Hendricks et al., 2022; Savona et al., 2021) and subject-matter experts as well as existing literature (Darabi & Hosseinichimeh, 2020; Levy et al., 2011; Morshed et al., 2019). WHO Health Behaviour in School-aged Children (HBSC) survey data for Norway from 2002 is used as the main data source for model initialization. HBSC is conducted every four years in over 40 countries on 11-, 13-, and 15-year-olds health and consumption behaviour, social environment and physical and mental well-being including self-reported height and weight (WHO, 2002). The survey data available for the years 2002, 2006, 2010 and 2014 were open access in 2021, and 2018 data that became available at the end of October 2022, were utilized for calibrating the model's behaviour over time. Detailed information about data sources of the model's parameters and initial values are shown in Appendix 1.

The System Dynamics modelling Process in CO-CREATE

Model Conceptualization

The structure of the simulation model is based on the conceptual map of systemic structures, integrating the views from adolescents, experts' knowledge, survey data, and literature. This integration of knowledge allowed us to formulate our overall conceptual model (see Figure 1) that we formalized and tested with the simulation SD model.

We integrated different knowledge sources to formulate the model:

- A diverse group of stakeholders including adolescents, researchers, policymakers, were brought together and deeply engaged in the development of the systems maps that contained the main drivers and feedback loops in youth obesity from the stakeholders' perspectives (Deliverable 4.1 *Obesity systems maps*). Stakeholder involvement was crucial for the model conceptualization stage in the modelling process.

- Deliverable 7.1 A *systematic review on existing system dynamics models on overweight and obesity in children and adolescents* played an important role during the conceptualization stages of the modelling process. The review results included the most archetypical and validated model structures available in the literature, the gaps in knowledge and the state of the art of childhood obesity research. These findings were useful in the subsequent stages in the modelling process as well (Aguiar, 2020).

- A series of model validation workshops with public health and obesity experts within CO-CREATE were conducted during the Spring of 2021: *Workshop 1 (February 2021) – Weight* *dynamics and PA environment, Workshop 2 (April 2021) – Food environment,* Workshop *3 (May 2021) - Mental well-being.* of dashboards or interactive interfaces during the modelling process. The modellers have used dashboards or interactive interfaces during these workshops, which facilitated communication and understanding among participants.

- From the policy briefs (Deliverable 5.3 *CO-CREATE youth alliances' policy briefs*) five policies were selected and Incorporated in the model to conduct sensitivity and scenario analyses.
- The integrated systems map (Deliverable 4.6 *Country and master maps* and Deliverable 4.5 *Structures for modelling*), along with the expert workshops' feedback. Our dynamic hypothesis shown in Figure 1, was then translated into a computational model to allow an understanding of dynamic trajectories over time.
- Research data from the Health Behaviour in School-aged Children (HBSC) study for Norway in year 2002, was utilized to initialize and calibrate the model and increase confidence in its structure.

Figure 1 shows the main model structure or conceptual model which includes the policy intervention points suggested by young people.

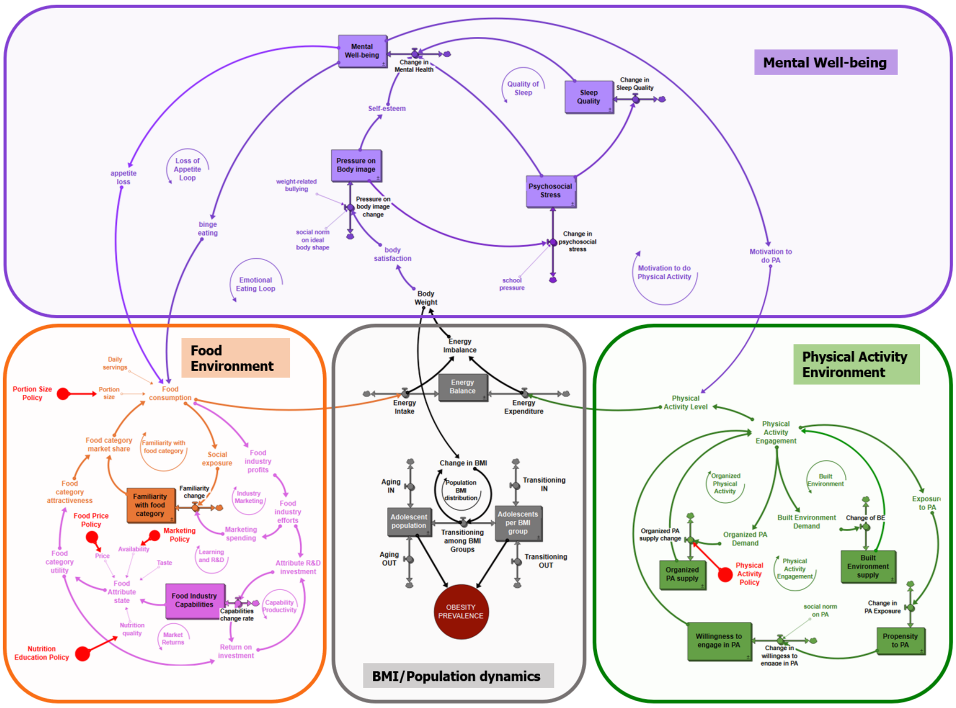

Figure 1. Aggregated model structure [Purple: Mental Well-being, Green: Physical Activity Environment, Orange: Food Environment, Grey: BMI/Population Dynamics, Red: Youth-suggested policy ideas]

Model Formulation

This section provide details and describes each module/sector of the SD model. The model has four main modules which interact with each other. These descriptions provide an overview of the structure of each module and their role in the model.

Population Weight Change Dynamics Sub-Model

Obesity prevalence is the main outcome variable of this module. The physiological module includes an aging chain composed of three stocks 11-, 13-, and 15-year-olds. People enter the first stock of adolescents of the chain when they turn 11 years old and they move into the next age group when they grow older, they leave the chain when they turn 17 years old.

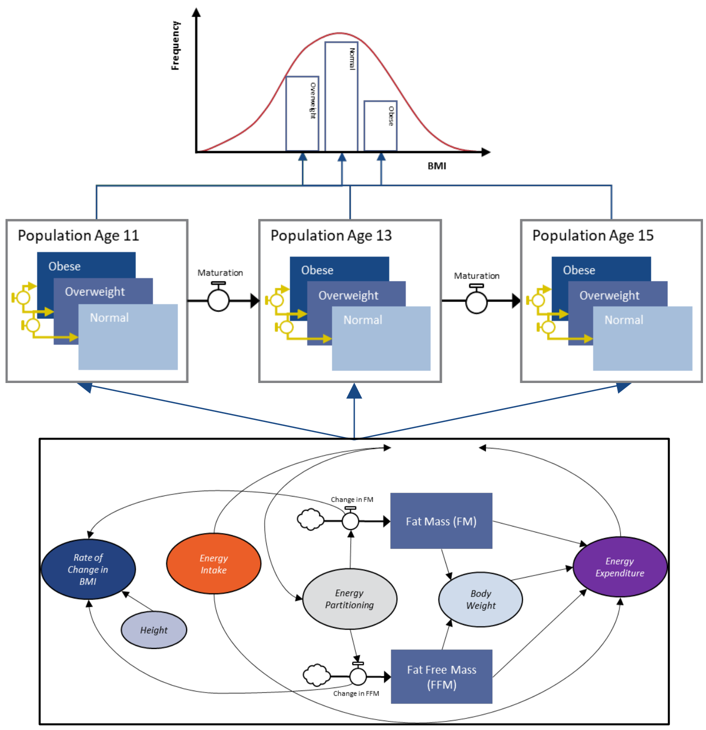

Figure 2. Body Weight Dynamics to BMI Distribution (adapted from Fallah-Fini et al. (2013)) [Orange: Energy intake, Purple: Energy expenditure]

Each population group remains 2 years in each age stock until they leave the chain. For each sub-population, we used the method developed and validated by Fallah-Fini et al. (2013, 2014) to simulate the dynamics of the population BMI distribution over time. Underlying this method is the model of the dynamics of weight gain and loss for representative individuals over time, including growth, by Hall (2008, 2010; 2009) to calculate the weight change a representative individual exhibits given an imbalance in energy intake and expenditure. Then, the change in BMI from the representative adolescent's body weight is turned into a population distribution among three weight BMI categories:

normal weight[2], overweight and obese. This representative individual denotes the average of people in each BMI category with respect to their BMI. After the stocks are initialized based on HBSC samples, the sub-populations of adolescents are allocated into their corresponding BMI categories as they are changing weight status.

Physical Activity Environment Sub-Model

The Physical Activity sub-models captures the factors influencing Physical Activity Level (PAL) and, thereby, determines energy expenditure in the physiological module which calculates a representative individual-level BMI and population-level prevalence of overweight and obesity. The four main stocks in this module are organized PA (i.e., organized activities after school) and self-organized PA, with the latter being driven by available built environment (i.e., green spaces, sidewalks, bike paths, sports facilities, etc.) which represent the supply component of PA environment. Investments in these two concepts within the PA environment are crucial to increase PA engagement in adolescents.

The stocks related to the demand side within the PA environment are willingness to engage in PA and propensity to engage in PA which are influenced by PA supply both from after school activities and for built environment. This module captures the interactions between these stocks to determine the total fraction of adolescents engaged in PA, which is then connected to the physiological module to determine PAL and then energy expenditure.

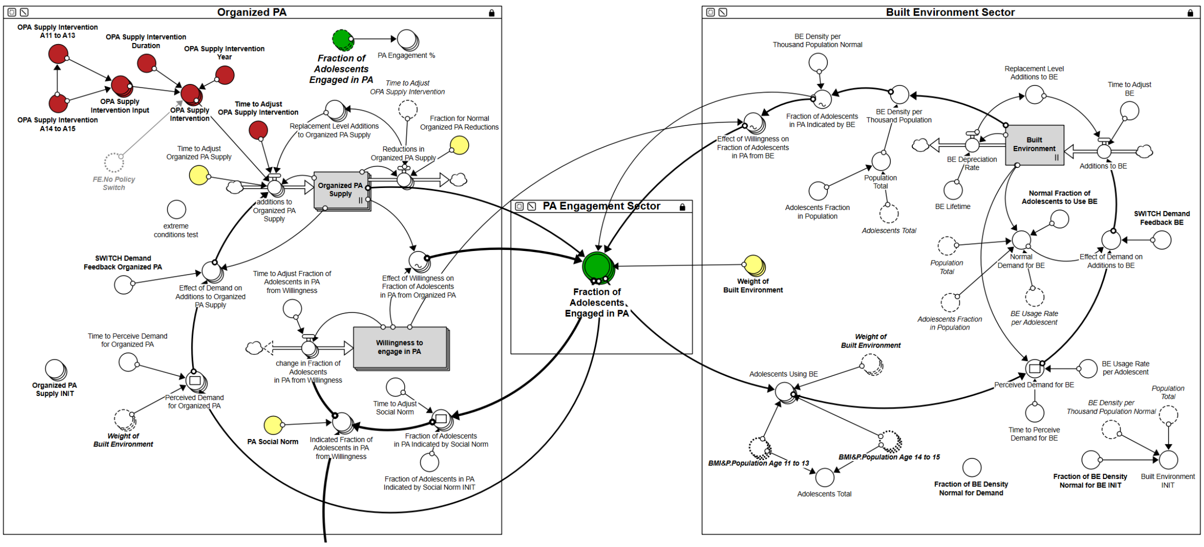

Figure 3. Organized Physical Activity and Built Environment Model Structure [Red: Policy entry, Green: Physical Activity, Yellow: Sensitivity Parameters]

While PAL impacts directly energy expenditure in the physiological module, age and gender from the physiological module impact the relative importance of organized and self-organized PA in total PA. Our main assumption across this module is that adolescents are more anchored to parental factors when younger like participating in more school PA activities, and less independent in decision-making,

[2] The normal weight total number of observations from the HBSC study include the underweight observations.

but turning more independent as they grow up. In this sense, older adolescents (age 14-and 15-year-olds) act more like adults and respond more by factors more typical for adult models of PA (built environment, peer support, motivation). The effect of the physical environment includes community infrastructure such as green spaces, gym facilities, sidewalks, bike paths, etc.

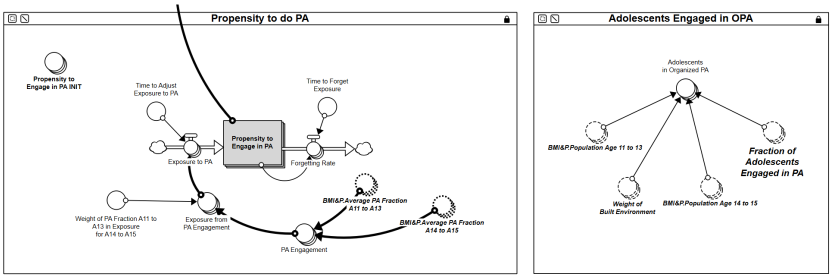

Figure 4. Physical Activity Demand Model Structure

Food Environment Sub-Model

The food environment module is based on the work developed by Struben et al. (2014). In this module, commercial food factors are included and formalized. The main two sectors in this module are demand, i.e., the consumer perspective, and supply, i.e., the food industry's perspective. The authors are representing two food categories: Highly nutritional and low nutritional foods. The central stock in the demand sector is the Familiarity to consume one of the two food categories. The central stock in the supply sector is Food industry capabilities, the accumulation of capabilities depends on productivity, total efforts, and the share of resources allocated to improving a particular food attribute (Struben et al., 2014). The food industry invests in food capabilities to obtain more profits. This is determined by the firm's efforts related to marketing and R&D investment.

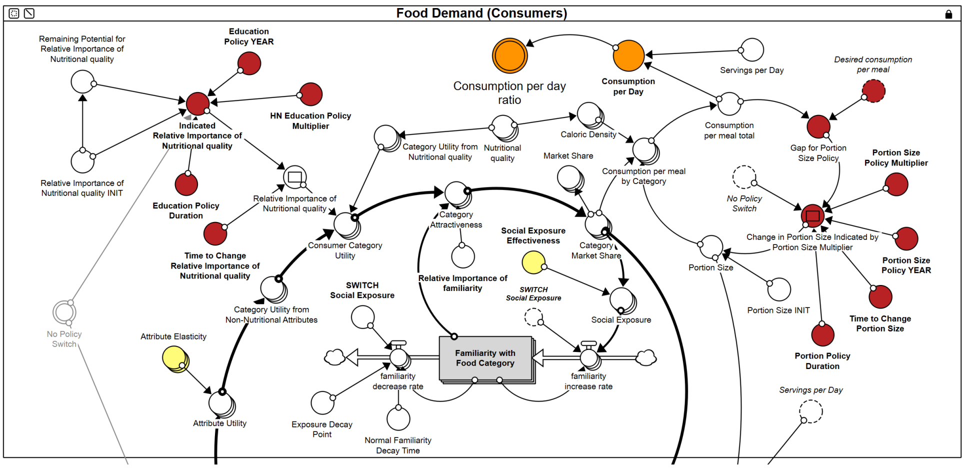

Figure 5. Food Demand Model Structure [Red: Policy entry, Orange: Energy intake, Yellow: Sensitivity Parameters]

The utility that consumers obtain from consuming a specific food category is determined by the state of its attributes, which improve as firms accumulate attribute-specific capabilities. Sales enable the development of such capabilities through learning and R&D.

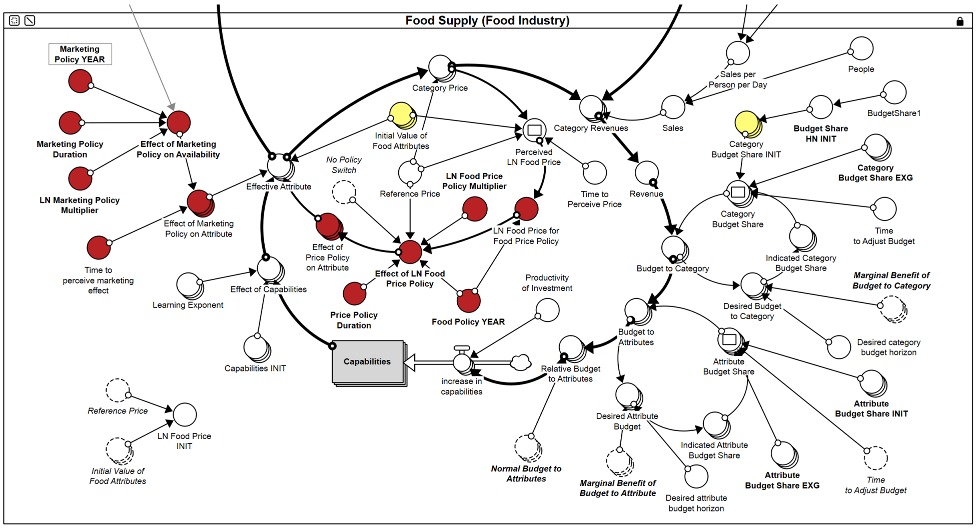

Figure 6. Food Supply Model Structure [Red: Policy entry, Yellow: Sensitivity Parameters]

The food industry inspects the market in order to allocate a greater portion of their reinvested resources toward categories and attributes that they presume will produce higher returns on investment. Greater food market shares as a result of food category improvements increase returns on investment even more.

Mental Wellbeing Sub-Model

The mental wellbeing module captures the main mental health-related processes that lead to obesity-related behaviours driving obesity such as emotional eating and lack of motivation to engage in PA. Due to scarce empirical evidence on the mental wellbeing feedback pathways to obesity-related behaviours, this sub-model relies structurally on the WP4 systems maps generated by adolescents, and on systematic reviews on the relationships between mental wellbeing and obesity in adolescents (Nwosu et al., Forthcoming) and calibrated with Norwegian data from the HBSC study. The main dynamics in this sub-model are generated by three reinforcing loops: emotional eating, motivation to do PA, and sleep quality.

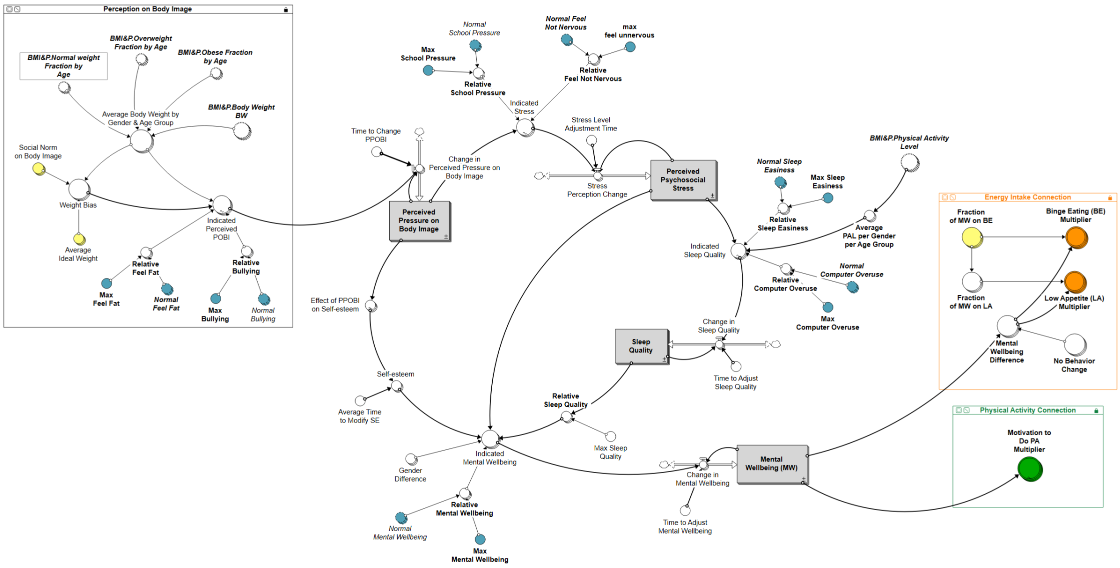

Figure 7. Mental Wellbeing Model Structure [Orange: Energy intake, Green: Physical Activity, Yellow: Sensitivity Parameters, Light blue: HBSC data]

Binge eating loop: Body weight → Body dissatisfaction → Pressure on body image → Self-esteem → Psychosocial stress → Emotional eating → Food consumption → Energy intake → Energy imbalance → Body weight

This feedback loop is initiated by a weight bias caused by the gap between the current and ideal weight of representative adolescents from each age group and gender. This weight bias leads to a perceived pressure on body image as it creates dissatisfaction related to the adolescent's weight status which contributes to reducing mental well-being and consequent obesity (Fismen et al., 2022). The pressure on body image contributes to an increment in psychosocial stress and to low self-esteem. Both psychosocial stress and low self-esteem are associated with poor mental well-being in adolescents. Particularly, psychosocial stress is composed of several external factors (known as stressors) such as school pressure and weight-related bullying, as well as perceived pressure on body image. The combination of increased psychosocial stress and poor mental well-being produce emotional eating behaviours that add extra calories to the normal calorie consumption via energy intake, leading to higher body weight, therefore, increasing the weight bias.

Motivation to do PA loop: Body weight → Body dissatisfaction → Pressure on body image → Psychosocial stress → Motivation to do PA → Physical activity engagement → Physical activity level → Energy expenditure → Energy imbalance → Body weight

This reinforcing loop describes the process initiated by adolescents feeling body dissatisfaction triggered by a gap between their current and ideal weight. Like in the emotional eating loop, the weight bias generates pressure on body image. As pressure on body image increases, psychosocial stress increases as well, reducing the motivation to do PA. The lower the motivation to do PA, the lower the physical activity engagement and physical activity level are. Lower PAL implies that less energy will be expended, therefore, producing a positive energy balance and higher body weight.

Model Validation

Simulation modelling not only helps observing the effect of feedback mechanisms at work in adolescents' environments on obesity outcomes, but also conducting experiments to better understand the dynamic complexity of the youth obesity issue. However, any simulation model-based study is typically subject to the question of how much confidence one should place in the analyses and results generated by the model. The system dynamics modelling process is iterative, in which various tests are used to scrutinize the model and to place confidence in its usefulness, such process generates insights into the relationship between the system's structure and behaviour (Homer, 2012) and that the outputs of the model are being generated for the right reasons (Barlas, 1996, p. 189).

We followed the model validation procedure as proposed by Sterman (2000) and Barlas (1996), Richardson and Pugh (1981), Forrester and Senge (1980), Hovmand (2014) consisting of a logical sequence as a guideline for carrying out model validity tests. The structural validation tests were carried out. Systems mapping sessions with adolescents, and workshops with domain experts including members of CO-CREATE, corroborated the mechanisms reflected in the model. We evaluated each equation against a variety of input values to ensure that it accurately captured the logic depicted in the literature and HBSC data and was robust under extreme conditions. In model equations, unit consistency was also ensured. Then, extreme condition tests were performed to discover faults in the model's behaviour that are difficult to detect from direct inspection or baseline behaviour e.g., if population stocks are initialized with zero, the simulated stocks should not show negative number of people.

Behaviour reproduction tests were also conducted to assess the model's capacity to reproduce the key variables of interest found in different scenarios of the four sub-models, which added to the model's usefulness. While these tests gave some confidence in the qualitative insights gained by our scenarios, it is important to note that the goal of this work was theory testing rather than prediction (de Gooyert, 2019). As a result, in the absence of specific quantitative data for such a detailed model, generalizing the findings or seeking practical guidance from our model should be approached with caution.

Sensitivity Analysis

The objective of sensitivity analysis is to establish how well the model results hold throughout a plausible range of values for the critical and most uncertain parameters. We recognize the constraints of developing complex models such as the one we built, where many of the parameters are essentially unknown due to the exploratory nature of the study and the high degree of aggregation. Eligible variables for the sensitivity analysis are chosen based on a solid understanding of the relevant assumptions in the overall reasoning of the structure. To ensure the model's outputs are reliable, we perform sensitivity analysis on the unknown model parameters, excluding table functions and structural uncertainty.

Sensitivity Analysis Procedure

In line with the system dynamics method, the focus is on behavioural rather than numerical sensitivity (Richardson & Pugh, 1981; Schwaninger & Groesser, 2011). Tailored parameter variation experiments were carried out, in which the key parameters governing the main outcome indicators were varied. We changed the value of the parameters by ±25% ranges and established a minimum and maximum value, where the medium value is the baseline as shown in Table 1. Two sensitivity levels are generally specified as low, and highly sensitive. We run the model 50 times for each parameter with 1234 seed using uniform distribution.

Table 1. Sensitivity Test results

#		Minimum	Baseline	Maximum	Low Sensitivity	High Sensitivity
	Food Environment					
1.	Social Exposure Effectiveness	0,075	0,1	0,125	√	
	Attribute Elasticity					
2.	*Taste*	3	4	5	√	
3.	*Availability*	3	4	5	√	
4.	*Price*	-5	-4	-3	√	
5.	Category Budget Share INIT, High Nutritious Food	0,375	0,5	0,625		√
	Initial Value of Food Attributes					
6.	*HN Taste*	0,6	0,8	1	√	
7.	*HN Availability*	0,75	1	1.25	√	
8.	*HN Price*	0,75	1	1.25	√	
9.	*LN Taste*	0,9	1,2	1,5		√
10.	*LN Availability*	0,9	1,2	1,5		√
11.	LN Price	0,6	0,8	1	√	
	Physical Activity Environment					
12.	PA Social Norm	0,375	0,5	0,625	√	
	Weight of Built Environment					
13.	*Male, Age 11-13*	0,225	0,3	0,375	√	
14.	*Male, Age 14-16*	0,525	0,7	0,875	√	
15.	*Female, Age 11-13*	0,225	0,3	0,375	√	
16.	*Female, Age 14-16*	0,525	0,7	0,7	√	
17.	Fraction for Normal OPA Reductions	0,0225	0,03	0,0375	√	
18.	Time to Adjust OPA	2.25 years	3 years	3.75 years	√	
	Mental Wellbeing Environment					
	Social norm on body image					
19.	*Male, Age 11*	0,82	1,10	1,37		√
20.	*Male, Age 13*	0,90	1,20	1,50		√
21.	*Male, Age 15*	0,97	1,30	1,62		√
22.	*Female, Age 11*	0,82	1,10	1,37		√
23.	*Female, Age 13*	0,91	1,22	1,52		√
24.	*Female, Age 15*	0,98	1,31	1,64		√

	Average ideal body weight					
25.	*Male, Age 11*	21,75	29	36,25		√
26.	*Male, Age 13*	27	36	45		√
27.	*Male, Age 15*	33,75	45	56,25		√
28.	*Female, Age 11*	21	28	35		√
29.	*Female, Age 13*	25,5	34	42,5		√
30.	*Female, Age 15*	29,25	39	48,75		√
31.	Time to change PPOBI	0,75 year	1 year	1,25 years	√	
32.	Fraction of MW on BE	0,6	0,8	1	√	
33.	Fraction of MW on LA	0,15	0,2	0,25	√	

The sensitivity analysis showed that the model is not sensitive to changes in the parameter values of the PA environment, in other words, the simulation outcomes changed by less than the change in the parameter value (+/- 25% for parameter values). The parameters in the PA environment do not compensate with the effects of the mechanisms acting in the food and mental well-being environments. Also, the PA environment effect are hindered by motivation to do PA the mental wellbeing sub-model.

The sensitivity analysis results will be reported two manuscripts of journal articles entitled and "*Understanding complex feedback mechanisms explaining the persistent prevalence of youth obesity. The CO-CREATE system dynamics simulation model*" and "*Mental health matters in obesity prevention: exploring the dynamic relationships between mental wellbeing and obesity-related behaviours in adolescents***"**. These articles are planned to be submitted as part of the CO-CREATE Supplement 2.

Model Calibration

In any modelling approach, the overall goal is to estimate as many parameters as possible directly from data. But sometimes there are some parameters for which data are not gathered, reliable data are not available, or we could not find them. In these situations, we can estimate parameter values by using calibration techniques.

Model Calibration Procedure

We conduct partial model calibration/testing for parameter estimation (Homer, 2012). In the partial model calibration, different pieces of the model are separately calibrated. This method is known to provide relatively robust estimates and decreases the chances of over-fitting the model. Though, the modern techniques such as automated calibration has some drawbacks for SD models most importantly the possibility of historical fit of the model behaviour analytically that might need to false confidence in the model (Oliva, 2003). Hence, it is important to note that the behaviour that the model generates should has to have right structure to do it. Therefore, the model is also validated for its causal structure through the literature and experts' inputs.

Model Calibration Results

Figure 8 shows the fit between model behaviour using the estimated parameter values and statistical data of AdOWOB prevalence. The simulated data approximately follows the historical trends against the HBSC data points from 2002-2018.

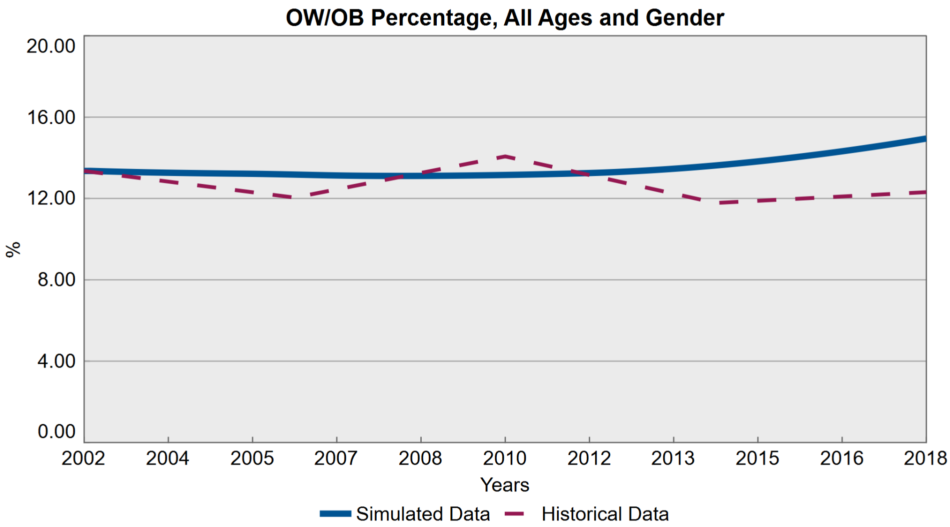

Figure 8. Model Estimation for Adolescent Overweight and Obesity Prevalence

To calculate the forecast error, Theil statistics were used to first calculate the mean-squared-error, then decompose it into the relative contributions of bias (U^M), unequal variation (U^S), and unequal covariance (U^C).

Table 2. Theil Statistics results summary

Model	U	U^M	U^S	U^C	MSE
Model Behaviour	0.060	35.45%	1.50%	63.05%	2.49
	n	**Mean**	**SD**		
OWOB Prevalence	5	13.65	0.67		
Historical Data	5	12.71	0.86		

U: Theil Inequality Coefficient, U^M: Mean Inequality, U^S: Variation Inequality, U^C: Covariation Inequality, SD: Standard Divisions, MSE: Mean Square Error

According to the results of the summary statistics, majority of the error is concentrated on the unequal covariance (U^C>U^M+U^S), meaning that even though the simulated data and the historical data do not match exactly, the model's forecasting error is not primarily composed of systematic biases (i.e., systematic deviations from the mean value) nor discrepancies with respect to the data's overall trend. Hence, this means that the model has no systematic error but some unsystematic error which is acceptable given that the model's purpose is to reflect the average value and trend through endogenous feedback mechanisms.

Policy Scenario Analysis

Analyses of the model consist of a series of simulated what-if experiments aimed at exploring the contribution of different feedback mechanisms, consisting of potent vicious cycles, on obesity trends. Analyses include sensitivity analysis to pinpoint the areas in which the model's behaviour is more sensitive to parameter changes whereby policy entry points may be identified; and scenarios experiments of potential policy ideas suggested by youth was also performed to investigate their impact on the direction of population-level obesity levels, and how vicious cycles can be turned into virtuous ones.

Description of the youth-suggested policy ideas in the model

Given that one of the goals of this model is to understand how policy ideas suggested by youth (Norwegian Institute of Public Health, 2020) could impact the socio-environmental and physiological feedback mechanisms that drive youth obesity, in this section we experiment with parameter changes and distil insights to improve understanding on how the policy ideas impact AdOWOB trends and other variables of interest. Five policies were suggested by youth at the youth alliances and their description in the model:

1. Increase unhealthy food price: in the model, this policy consists of changing the price attribute of LN food to be lower than high nutritious food in terms of capability improvements from the food industry. This is not a specific price in a specific country, it is rather an attribute of each food category. This attribute influences the reinforcing feedback loop that determines the attribute utility that customers give to certain food category.

2. Limit unhealthy food marketing: this policy entails a reduction on the availability attribute of the LN food attribute. This attribute influences the reinforcing feedback loop that determines the attribute utility that customers give to certain food category.

3. Reduce portion size: Maximum reduction of portion size (Maximum value is 1) relative to a gap reduction against a standard portion size and an incremented portion size. This is a dynamic gap, so the behaviour in the model shows the impact of a policy in a reduction or widening of that gap in portion size. This is a policy entry that is outside of the major feedback loops at work in the food environment, affects the food consumption directly.

4. More access to PA facilities in schools: this policy consists of increasing the Organized Physical Activity supply in schools for adolescents to engage more in PA by increasing their exposure to school activities, equipment and built environment.

5. Improve nutrition education: this policy consists of the relative importance consumers give to HN food category and this determines the food category attractiveness. This can be considered as the 'health awareness' people have with respect to healthy food that comes from nutrition education and health awareness.

Policy Scenario Procedure

We run policy scenarios multi-varied with ad-hoc methods for each policy option's magnitude and/or duration values for the values mentioned in Table 3. Except the base scenario, the values for magnitude and/or duration parameters are tested within a range to observe the systems reaction to a policy and/or policy combination. In the table, tested values are shown as bold text and the base values are shown as normal text.

Table 3 shows a summary of the policy scenario results and an indication on whether the scenario resulted in a low or high sensitivity in the behaviour of the AdOWOB prevalence.

Table 3 Summary of Policy Analysis Results

<table>
<tr><th>Name of the Policy</th><th colspan="4">Magnitude
(Percentage %)</th><th>Duration
(years)</th><th>Low
Sensitivity</th><th>High
Sensitivity</th></tr>
<tr><td>Base Scenario</td><td colspan="4"></td><td></td><td></td><td></td></tr>
<tr><td>1. Increase unhealthy food price</td><td colspan="4">5</td><td>5</td><td></td><td></td></tr>
<tr><td>2. Limit unhealthy food marketing</td><td colspan="4">5</td><td>5</td><td></td><td></td></tr>
<tr><td>3. Reduce portion size</td><td colspan="4">5</td><td>5</td><td></td><td></td></tr>
<tr><td>4. More access to PA facilities in schools</td><td colspan="4">5</td><td>5</td><td></td><td></td></tr>
<tr><td>5. Improve nutrition education</td><td colspan="4">5</td><td>5</td><td></td><td></td></tr>
<tr><td colspan="8">Policy magnitude sensitivity</td></tr>
<tr><td colspan="8">Policy Scenario 1:
Sensitivity analysis varying all food policies magnitude in increments of 15%, 25% and 50%</td></tr>
<tr><td colspan="8">Policy Scenario 1-A:
Varying the 4 food policies at the same time and incrementally from 15%, 25% and 50%, keeping PA policy as the baseline (5% magnitude and 5 years duration).</td></tr>
<tr><td>1. Increase unhealthy food price</td><td colspan="4">15, 25, 50</td><td>5</td><td></td><td rowspan="4">√</td></tr>
<tr><td>2. Limit unhealthy food marketing</td><td colspan="4">15, 25, 50</td><td>5</td><td></td></tr>
<tr><td>3. Reduce portion size</td><td colspan="4">15, 25, 50</td><td>5</td><td></td></tr>
<tr><td>4. More access to PA facilities in schools</td><td colspan="4">15, 25, 50</td><td>5</td><td></td></tr>
<tr><td>5. Improve nutrition education</td><td colspan="4">5</td><td>5</td><td></td><td></td></tr>
<tr><td colspan="8">Policy Scenario 1-B
Comparing the food policies with each other with 50% magnitude, keeping the PA policy with 5 years duration</td></tr>
<tr><td>1. Increase unhealthy food price</td><td>50</td><td>5</td><td>5</td><td>5</td><td>5</td><td></td><td>√</td></tr>
<tr><td>2. Limit unhealthy food marketing</td><td>5</td><td>50</td><td>5</td><td>5</td><td>5</td><td>√</td><td></td></tr>
<tr><td>3. Reduce portion size</td><td>5</td><td>5</td><td>50</td><td>5</td><td>5</td><td></td><td>√</td></tr>
<tr><td>4. More access to PA facilities in schools</td><td>5</td><td>5</td><td>5</td><td>50</td><td>5</td><td></td><td>√</td></tr>
<tr><td>5. Improve nutrition education</td><td>5</td><td>5</td><td>5</td><td>5</td><td>5</td><td></td><td></td></tr>
<tr><td colspan="8">Policy Scenario 2</td></tr>
</table>

Sensitivity analysis of the physical activity (PA) policy in increments of 10%, 15%, 50% magnitude, keeping the PA policy with 5 years duration					
Policy Scenario 2-A **Comparing the PA policy increments of 15%, 25% and 50% magnitude, keeping the food policies as baseline scenario**					
1. Increase unhealthy food price	5		5		
2. Limit unhealthy food marketing	5		5		
3. Reduce portion size	5		5		
4. More access to PA facilities in schools	5		5		
5. Improve nutrition education	**15, 25, 50**		5	√	
Policy Scenario 2-B **Comparing the PA policy comparing incrementally the two age groups (younger and older adolescents)**					
1. Increase unhealthy food price	5		5		
2. Limit unhealthy food marketing	5		5		
3. Reduce portion size	5		5		
4. More access to PA facilities in schools	5		5		
5. Improve nutrition education					
Younger Adolescents	**15,25,50**	5	5	√	
Older Adolescents	5	**15,25,50**	5	√	
Policy Scenario 3 **Combination of policy increments of 15%, 25% and 50% magnitude in all policies**					
1. Increase unhealthy food price	**15, 25, 50**		5		√
2. Limit unhealthy food marketing	**15, 25, 50**		5		
3. Reduce portion size	**15, 25, 50**		5		
4. More access to PA facilities in schools	**15, 25, 50**		5		
5. Improve nutrition education	**15, 25, 50**		5		
Policy duration sensitivity					
Policy Scenario 4: **Varying the food policies duration incrementally from 10, 15 and 20 years, keeping PA policy as the baseline (5 years).**					
1. Increase unhealthy food price	5		**10, 15, 20**		√
2. Limit unhealthy food marketing	5		**10, 15, 20**		
3. Reduce portion size	5		**10, 15, 20**		
4. More access to PA facilities in schools	5		**10, 15, 20**		
5. Improve nutrition education	5		5		
Policy Scenario 5: **Varying the PA policy in increments of 10 years, 15 years, and 20 years policy duration. In this scenario, all food policies are kept with 5 years duration.**					
1. Increase unhealthy food price	5		5		
2. Limit unhealthy food marketing	5		5		
3. Reduce portion size	5		5		

4. More access to PA facilities in schools	5	5		
5. Improve nutrition education	5	**10, 15, 20**	√	
Policy Scenario 6: **Both food and PA policies are varied incrementally in 10, 15, and 20 years of policy duration.**				
1. Increase unhealthy food price	5	**10, 15, 20**		
2. Limit unhealthy food marketing	5	**10, 15, 20**		
3. Reduce portion size	5	**10, 15, 20**		√
4. More access to PA facilities in schools	5	**10, 15, 20**		
5. Improve nutrition education	5	**10, 15, 20**		
Policy magnitude and duration sensitivity				
Policy Scenario 7: **Both food policies and PA policies are varied incrementally in magnitude (%) and duration (years)**				
1. Increase unhealthy food price	**15, 50**	**10, 20**		
2. Limit unhealthy food marketing	**15, 50**	**10, 20**		
3. Reduce portion size	**15, 50**	**10, 20**		√
4. More access to PA facilities in schools	**15, 50**	**10, 20**		
5. Improve nutrition education	**15, 50**	**10, 20**		

Policy Scenario Analysis Results

The results of the policy scenario analysis will be reported two manuscripts of journal articles entitled and "*Understanding complex feedback mechanisms explaining the persistent prevalence of youth obesity. The CO-CREATE system dynamics simulation model" and "Mental health matters in obesity prevention: exploring the dynamic relationships between mental wellbeing and obesity-related behaviours in adolescents***"**. These articles are planned to be submitted as part of the CO-CREATE Supplement 2.

Collaboration with Project Partners

There has been a strong collaboration between WP7 modelling team and other work packages, specifically, the lead modeller has closely worked with WP4 and the UCT team throughout the modelling process. There have also been several presentations and workshops with experts within the project to help validate the structure and behaviour of the model. The collaborative tasks have included: modelling training both qualitative and quantitative, systems map feedback comments, joint model-building, and article collaboration.

Joint publications: (Savona et al., 2021); (Hendricks et al., 2022); Hendricks et al., 2022; Nwosu et al., Forthcoming; Blanchard et al., Forthcoming, (Aguiar et al., 2019), Aguiar et al. Forthcoming, Aguiar et al. Forthcoming.

Discussion and Reflections

Throughout the modelling process, we have integrated knowledge from different sources - such as literature review, stakeholder, and expert inputs, and HBSC survey data. System dynamics modelling was applied to build a simulation model that contains the core feedback mechanisms driving adolescent AdOWOB behaviours and prevalence. The model consists of four sub-models that interact with each other.

To achieve the WP7 Objective 7.1 and Task 7.1, we started developing the SD model that would serve as a knowledge repository and as a policy evaluation tool. The original plan was to use one model for both purposes. We started developing the model explaining the feedback mechanisms leading to AdOWOB. However, we understood in our work that policy evaluation requires incorporating Socio-Economic Status SES and taking a pan-European/multi-country perspective in the model. This is challenging to do with the detailed mechanism model approach, both in terms of complexity and data availability. We overcame these limitations in part by developing a separate more compact SD model for policy evaluation that could be rigorously calibrated to data (Details can be found in D7.2). On the other hand, it is still important to understand in detail how the mechanisms, especially mental well-being mechanisms work and lead to changes in EBRB and AdOWOB prevalence, therefore, the 'mechanisms model' in D7.3 is needed. The two modelling efforts complement each other in achieving the objectives of WP7.

Our experience in applying the SD method for building a simulation model that could serve as a knowledge repository containing findings from previous work packages (WP3, WP4 and WP5) revealed that SD models are useful to gain insight on how a complex problem may be understood and alleviated. SD models can be used as a virtual laboratory that allows for repeated experimentation with the system, such as testing assumptions or adjusting and revising policies strategies. Our modelling process also demonstrated that a highly aggregated model is useful to grasp the 'big picture' when discussing obesity from a systems perspective.

The quantification of soft variables often yields important insight into the dynamics of a system (Coyle, 2000; Forrester, 1961). Therefore, in this modelling work, we have focused our modelling efforts to represent and quantify intangible variables that are mostly present in the mental wellbeing sub-model such as stress, perception on body weight, self-esteem, etc. These factors have been studied separately with other methods but missing the dynamic feedback insights that a simulation model can provide over time.

Recommendations for Future Use of the Model

This model is designed to be used by both adolescents and policy makers as an explanatory tool to understand obesogenic environments (Swinburn et al., 2011) from a system's perspective and how the components of this system are connected through multiple cause and effect relationships that generates feedback mechanisms leading to AdOWOB prevalence. In addition, the model is expected to be used in an inferential manner to explore future scenarios and the system's response to various policy strategies, as well as to identify the leverage points for potential policy strategies.

Our recommendations for those attempting to build upon our work or starting a similar modelling project are threefold. First, we support the importance of conducting systematic reviews on existing system dynamics models, and other modelling approaches on childhood obesity, especially during the conceptualization and validation stage. Furthermore, involving stakeholders in every step of the modelling process increases ownership and confidence in the model structure. The second suggestion is to seek for access to comprehensive data that measures BMI, physical activity level, and dietary factors relevant to the chosen context. Third, the population-level dynamics of AdOWOB are indeed the product of numerous complex mechanisms functioning at and individual scale but influenced by societal forces (Lee et al., 2000; Swinburn et al., 2011). It is difficult to quantify such mechanisms for an aggregated population-level model since the results of targeted research (e.g., RCTs or longitudinal studies) are frequently context-specific and harder to generalize. Also, there is a wide range of data and perspectives about the determinants of AdOWOB that needs to be discussed and agreed upon early within the project. A closer integration of quantitative data with the model should enhance confidence in the results, therefore, it is important to secure relevant datasets to initialize and calibrate the model. Additionally, models with this high level of aggregation allow the opportunity to calibrate it to other countries as well as generate and test context-specific interventions.

We also highlight the value of dashboards or interactive interfaces during the modelling process. By creating dashboards linked to the simulation model, we ensure stakeholder engagement, facilitate communication of model results, and help demystifying quantitative models' usage in the field of public health. A self-standing user model interface is desirable, however in this case this suggestion if considered an addition to the core activities of this project.

Building on our modelling efforts in CO-CREATE, we urge future project initiatives addressing complex challenges to create and co-develop SD models that are both qualitative (in the form of systems maps) and quantitative simulation models. Even though the SD models may be used to expand research, create new hypotheses to test, and facilitate rich and interactive dialogues among stakeholders, the modelling process itself has shown to be a valuable experience for researchers and stakeholders. Bringing people together to discuss complex problems from a systems viewpoint can spark change and shift procedures to address important health concerns.

Conclusion

Our work reveals system dynamics methods can play an important role in gaining insights about the relationship between feedback structure and dynamic behaviour of a system and identifying leverage points at which policies may effectively be introduced and tested. By pinpointing causal explanations and supporting them with computer simulations, SD allows stakeholders and decisionmakers to examine feedback loops in the systems at hand and explore policy options that could improve the system's performance by potentiating or breaking the feedback loops. The causal loop diagrams that emerged from CO-CREATE group model building sessions, therefore, act as a dynamic hypothesis that can be tested through building a simulation model. The main structures that were generic from all the sources were distilled to be formalized and tested in the simulation model and with appropriate calibration of initial values and exogenous variables, reproduced the main AdOWOB behaviour trends.

The WP7 system dynamics model that resulted is a structured synthesis of knowledge generated through a participatory approach involving stakeholders and existing evidence from expert opinions and literature. It thus constitutes a knowledge repository that can be subjected to formal, simulation-based analysis and that serves as the foundation for a gradual, experience-based improvement of current understanding on which co-created policies are based and acted upon. Furthermore, model formalization and calibration in accordance with theories, as well as empirical evidence and simulation in a computer program, allows examination of the system's fundamental cause-and-effect behaviour and the effects of co-created policies in the system as well as their direct and indirect, short- and long-term implications.

Model Access

The model is provided as an open-source deliverable, including full documentation of the model's parameters, equations, and main assumptions available in Appendix 4. The model can be downloaded from the following link

- Co-Create Mechanisms Model (D7.3): https://github.com/bkopains/Co-Create-mechanism-model

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Appendices

Appendix 1. Data Sources, Parameters, and Initial Values

Table 4 summarizes the data sources used in the model.

Table 4. Data Sources

Module	*Variable*	*Source*
BMI and Population		
	INIT adolescents per BMI Group	Number of 11-, 13-, and 15-years-olds by gender based on HBSC sample size (HBSC, 2002) https://hbsc.org/data/
Mental Health		
	Maximum bullying	Maximum value defined by the HBSC survey response scale by gender and age group (HBSC, 2002, 2006, 2010, 2018) https://hbsc.org/data/
	Maximum computer overuse	Maximum value defined by the HBSC survey response scale by gender and age group (HBSC, 2002, 2006, 2010, 2018) https://hbsc.org/data/
	Maximum mental wellbeing	Maximum value defined by the HBSC survey response scale by gender and age group (HBSC, 2002, 2006, 2010, 2018) https://hbsc.org/data/
	Maximum school pressure	Maximum value defined by the HBSC survey response scale by gender and age group (HBSC, 2002, 2006, 2010, 2018) https://hbsc.org/data/
	Maximum sleep easiness	Maximum value defined by the HBSC survey response scale by gender and age group (HBSC, 2002, 2006, 2010, 2018) https://hbsc.org/data/
	Maximum feeling not nervous	Maximum value defined by the HBSC survey response scale by gender and age group (HBSC, 2002, 2006, 2010, 2018) https://hbsc.org/data/
	Maximum feeling fat	Maximum value defined by the HBSC survey response scale by gender and age group (HBSC, 2002, 2006, 2010, 2018) https://hbsc.org/data/
	Normal mental wellbeing	The average value calculated with the HBSC survey data by gender and age group (HBSC, 2002, 2006, 2010, 2018) https://hbsc.org/data/
	Normal not feeling not nervous	The average value calculated with the HBSC survey data by gender and age group (HBSC, 2002, 2006, 2010, 2018) https://hbsc.org/data/
	Normal sleep easiness	The average value calculated with the HBSC survey data by gender and age group (HBSC, 2002, 2006, 2010, 2018) https://hbsc.org/data/
	Normal computer overuse	The average value calculated with the HBSC survey data by gender and age group (HBSC, 2002, 2006, 2010, 2018) https://hbsc.org/data/
	Normal school pressure	The average value calculated with the HBSC survey data by gender and age group (HBSC, 2002, 2006, 2010, 2018) https://hbsc.org/data/
	Normal feeling fat	The average value calculated with the HBSC survey data by gender and age group (HBSC, 2002, 2006, 2010, 2018) https://hbsc.org/data/

Weight related bullying	The average value calculated with the HBSC survey data by gender and age group (HBSC, 2002, 2006, 2010, 2018) https://hbsc.org/data/

Parameter Values

Table 5 presents the parameters used in the model including their values, comments, units, and sources.

Table 5. Parameters of the Model

Module	*Sector*	*Parameter*	*Value*	*Unit*	*Comment*	*Source*
BMI and Population						
	Aging Chain	Maturation time A10 to 11	2	Years	This parameter represents the time it takes for adolescents to mature and enter the aging chain	Estimated from partial model calibration to fit the historical data
	Aging Chain	Maturation Time Youth	2	Years	This parameter represents the time it takes for adolescents to mature and move to the next age cohort in the aging chain	Estimated from partial model calibration to fit the historical data
	Aging Chain	Maturation Time Youth to exit the aging chain	2	Years	This parameter represents the time it takes for adolescents to mature and exit the aging chain when they turn 17 years old	Estimated from partial model calibration to fit the historical data
	BMI Distribution	BMI Coefficient for FM Fraction Reference	1.51	(m^2)/kg	This parameter is the associated coefficient that multiplies the BMI representative value in the FM fraction reference equation	Cortes-Castell et al., 2017
	BMI Distribution	Height (Male, Age 11)	1.47	Meters	This parameter indicates the adolescent's height according to their age and gender	The Bergen Growth Study 1 and 2 https://www.vekststudien.no/category/about-the-growth-curves/
	BMI Distribution	Height (Male, Age 13)	1.59	Meters	This parameter indicates the adolescent's height according to their age and gender	The Bergen Growth Study 1 and 2 https://www.vekststudien.no/category/about-the-growth-curves/
	BMI Distribution	Height (Male, Age 15)	1.73	Meters	This parameter indicates the adolescent's height according to their age and gender	The Bergen Growth Study 1 and 2 https://www.vekststudien.no/category/about-the-growth-curves/
	BMI Distribution	Height (Female, Age 11)	1.47	Meters	This parameter indicates the adolescent's height according to their age and gender	The Bergen Growth Study 1 and 2 https://www.vekststudien.no/category/about-the-growth-curves/
	BMI Distribution	Height (Female, Age 13)	1.58	Meters	This parameter indicates the adolescent's height according to their age and gender	The Bergen Growth Study 1 and 2 https://www.vekststudien.no/category/about-the-growth-curves/
	BMI Distribution	Height (Female, Age 15)	1.66	Meters	This parameter indicates the adolescent's height according to their age and gender	The Bergen Growth Study 1 and 2

Module	*Sector*	*Parameter*	*Value*	*Unit*	*Comment*	*Source*
						https://www.vekststudien.no/category/about-the-growth-curves/
		Multiplier for Leaving Down Rate First Bin, Normal Weight	0	Dimensionless	This is an operational parameter to activate the formulation Leaving Down Rate that calculates the number of individuals moving from one BMI group to another	Parameter value elicited from experts' input during domain experts' workshops
		Multiplier for Leaving Down Rate First Bin, Overweight	1	Dimensionless	This is an operational parameter to activate the formulation Leaving Down Rate that calculates the number of individuals moving from one BMI group to another	Parameter value elicited from experts' input during domain experts' workshops
		Multiplier for Leaving Down Rate First Bin, Obese	1	Dimensionless	This is an operational parameter to activate the formulation Leaving Down Rate that calculates the number of individuals moving from one BMI group to another	Parameter value elicited from experts' input during domain experts' workshops
		Multiplier for Leaving Up Rate First Bin, Normal Weight	1	Dimensionless	This is an operational parameter to activate the formulation Leaving Up Rate that calculates the number of individuals moving from one BMI group to another	Parameter value elicited from experts' input during domain experts' workshops
		Multiplier for Leaving Up Rate First Bin, Overweight	1	Dimensionless	This is an operational parameter to activate the formulation Leaving Up Rate that calculates the number of individuals moving from one BMI group to another	Parameter value elicited from experts' input during domain experts' workshops
		Multiplier for Leaving Up Rate First Bin, Obese	0	Dimensionless	This is an operational parameter to activate the formulation Leaving Up Rate that calculates the number of individuals moving from one BMI group to another	Parameter value elicited from experts' input during domain experts' workshops
		Xfin, Normal Weight, Male, Age 11	20.55	kg/m^2	This parameter represents the end BMI value associated with the Normal Weight BMI group of male adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xfin, Normal Weight, Male, Age 13	21.91	kg/m^2	This parameter represents the end BMI value associated with the Normal Weight BMI group of male adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xfin, Normal Weight, Male, Age 15	23.29	kg/m^2	This parameter represents the end BMI value associated with the Normal Weight BMI group of male adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xfin, Normal Weight, Female, Age 11	20.74	kg/m^2	This parameter represents the end BMI value associated with the Normal Weight BMI group of female adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007

Module	Sector	Parameter	Value	Unit	Comment	Source
		Xfin, Normal Weight, Female, Age 13	22.58	kg/m^2	This parameter represents the end BMI value associated with the Normal Weight BMI group of female adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xfin, Normal Weight, Female, Age 15	23.94	kg/m^2	This parameter represents the end BMI value associated with the Normal Weight BMI group of female adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xfin, Overweight, Male, Age 11	25.10	kg/m^2	This parameter represents the end BMI value associated with the Overweight BMI group of male adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xfin, Overweight, Male, Age 13	26.84	kg/m^2	This parameter represents the end BMI value associated with the Overweight BMI group of male adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xfin, Overweight, Male, Age 15	28.30	kg/m^2	This parameter represents the end BMI value associated with the Overweight BMI group of male adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xfin, Overweight, Female, Age 11	25.42	kg/m^2	This parameter represents the end BMI value associated with the Overweight BMI group of female adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xfin, Overweight, Female, Age 13	27.76	kg/m^2	This parameter represents the end BMI value associated with the Overweight BMI group of female adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xfin, Overweight, Female, Age 15	29.11	kg/m^2	This parameter represents the end BMI value associated with the Overweight BMI group of female adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xfin, Obese, Male, Age 11	28.02	kg/m^2	This parameter represents the end BMI value associated with the Obese BMI group of male adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xfin, Obese, Male, Age 13	29.79	kg/m^2	This parameter represents the end BMI value associated with the Obese BMI group of male adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xfin, Obese, Male, Age 15	31.56	kg/m^2	This parameter represents the end BMI value associated with the Obese BMI group of male adolescents aged	Katzmarzyk et al., 2007

Module	Sector	Parameter	Value	Unit	Comment	Source
					15 based on the BMI cut offs by Katzmarzyk et al.	
		Xfin, Obese, Female, Age 11	28.02	kg/m²	This parameter represents the end BMI value associated with the Obese BMI group of female adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xfin, Obese, Female, Age 13	29.79	kg/m²	This parameter represents the end BMI value associated with the Obese BMI group of female adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xfin, Obese, Female, Age 15	31.56	kg/m²	This parameter represents the end BMI value associated with the Obese BMI group of female adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Normal Weight, Male, Age 11	14.00	kg/m²	This parameter represents the start BMI value associated with the Normal Weight BMI group of male adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Normal Weight, Male, Age 13	14.00	kg/m²	This parameter represents the start BMI value associated with the Normal Weight BMI group of male adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Normal Weight, Male, Age 15	14.00	kg/m²	This parameter represents the start BMI value associated with the Normal Weight BMI group of male adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Normal Weight, Female, Age 11	14.00	kg/m²	This parameter represents the start BMI value associated with the Normal Weight BMI group of female adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Normal Weight, Female, Age 13	14.00	kg/m²	This parameter represents the start BMI value associated with the Normal Weight BMI group of female adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Normal Weight, Female, Age 15	14.00	kg/m²	This parameter represents the start BMI value associated with the Normal Weight BMI group of female adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Overweight, Male, Age 11	20.55	kg/m²	This parameter represents the start BMI value associated with the Overweight BMI group of male adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007

Module	Sector	Parameter	Value	Unit	Comment	Source
		Xinit, Overweight, Male, Age 13	21.91	kg/m²	This parameter represents the start BMI value associated with the Overweight BMI group of male adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Overweight, Male, Age 15	23.29	kg/m²	This parameter represents the start BMI value associated with the Overweight BMI group of male adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Overweight, Female, Age 11	20.74	kg/m²	This parameter represents the start BMI value associated with the Overweight BMI group of female adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Overweight, Female, Age 13	22.58	kg/m²	This parameter represents the start BMI value associated with the Overweight BMI group of female adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Overweight, Female, Age 15	23.94	kg/m²	This parameter represents the start BMI value associated with the Overweight BMI group of female adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Obese, Male, Age 11	25.10	kg/m²	This parameter represents the start BMI value associated with the Obese BMI group of male adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Obese, Male, Age 13	26.84	kg/m²	This parameter represents the start BMI value associated with the Obese BMI group of male adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Obese, Male, Age 15	28.30	kg/m²	This parameter represents the start BMI value associated with the Obese BMI group of male adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Obese, Female, Age 11	25.42	kg/m²	This parameter represents the start BMI value associated with the Obese BMI group of female adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Obese, Female, Age 13	27.76	kg/m²	This parameter represents the start BMI value associated with the Obese BMI group of female adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al.	Katzmarzyk et al., 2007
		Xinit, Obese, Female, Age 15	29.11	kg/m²	This parameter represents the start BMI value associated with the Obese BMI group of female adolescents aged	Katzmarzyk et al., 2007

Module	*Sector*	*Parameter*	*Value*	*Unit*	*Comment*	*Source*
					15 based on the BMI cut offs by Katzmarzyk et al.	
		Year of Age, Age 11	11	Dimensionless	This parameter indicates the years of age that determines the fat mass (FM) fraction reference equation	Cortes-Castell et al., 2017
		Year of Age, Age 13	13	Dimensionless	This parameter indicates the years of age that determines the fat mass (FM) fraction reference equation	Cortes-Castell et al., 2017
		Year of Age, Age 15	15	Dimensionless	This parameter indicates the years of age that determines the fat mass (FM) fraction reference equation	Cortes-Castell et al., 2017
	Body Weight dynamics	Ae, Male	3.20	kcal/day	This is a constant which indicates the parameter for calculation of growth function. It represents the required amount of kcal per day for physiological processes during growth for each sex	Hall, 2013
		Ae, Female	2.30	kcal/day	This is a constant which indicates the parameter for calculation of growth function. It represents the required amount of kcal per day for physiological processes during growth for each sex	Hall, 2013
		Base Energy Expenditure	8000	kcal/year	This is a constant that represents the base energy expenditure for physical activity	Hall, 2013
		Be, Male	9.60	kcal/day	This is a constant which indicates the parameter for calculation of growth function. It represents the required amount of kcal per day for physiological processes during growth for each sex	Hall, 2013
		Be, Female	8.40	kcal/day	This is a constant which indicates the parameter for calculation of growth function. It represents the required amount of kcal per day for physiological processes during growth for each sex	Hall, 2013
		Betta	0.24	Dimensionless	This is a constant that represents the adaptive thermogenesis parameter (Beta) which is the energy requirement per kcal after a change in diet	Hall, 2008; Hall et al., 2009; Hall, 2010
		C	10.40	kg	This is a constant that represents the Forbes' body composition coefficient. The number is the result of a parameterization by Forbes to fit the logarithmic function that Forbes is used to relate fat free mass to fat mass based on a cross-sectional data set	Chow and Hall, 2008; Hall et al., 2009; Hall, 2010; Forbes, 1987; Hall, 2008; 2010
		Days in a year	365	days/year	This is a constant that represents the number of days in a year.	Simon et al., 1994

Module	Sector	Parameter	Value	Unit	Comment	Source
		Days per year	365	days/year	This is a constant that represents the number of days in a year.	Simon et al., 1994
		De, Male	10.10	kcal/day	This is a constant which indicates the parameter for calculation of growth function. It represents the required amount of kcal per day for physiological processes during growth for each sex	Hall, 2013
		De, Female	1.10	kcal/day	This is a constant which indicates the parameter for calculation of growth function. It represents the required amount of kcal per day for physiological processes during growth for each sex	Hall, 2013
		EtaF	180	kcal/kg	This is a constant that represents the energy cost for fat turnover which is proportional to change in fat mass	Hall, 2008; Hall et al., 2009; Hall, 2010
		EtaL	230	kcal/kg	This is a constant that represents the energy cost for protein turnover which is proportional to change in fat free mass	Hall, 2008; Hall et al., 2009; Hall, 2010
		Gamma Fat Mass	3.20	kcal/kg	This is a constant that represents the resting metabolic rate regression coefficient per fat mass	Nelson et al., 1992; Hall, 2010; Hall et al., 2009
		Gamma Lean Mass	22.00	kcal/kg	This is a constant that represents the resting metabolic rate regression coefficient per fat free mass	Nelson et al., 1992; Hall, 2010; Hall et al., 2009
		KConstant	370.21	kcal	This is a constant that is determined by the initial energy balance conditions	Chow and Hall, 2008; Hall et al., 2009; Hall, 2010
		PAL Active	1.5	Dimensionless	This is a constant that represents the average physical activity level of adolescents who are active.	Food and Agriculture Organization of the United Nations (FAO), 2004
		PAL Sedentary	1	Dimensionless	This is a constant that represents the average physical activity level of adolescents who are not active.	FAO, 2004
		Reference PAL coefficient	7.00	kcal/(kg*day)	This is a constant that represents the reference or initial physical activity coefficient. The value is an approximation of physical activity of a person who is sedentary	Hall et al., 2009, Hall, 2010
		RhoF	9400	kcal/kg	This is a constant that represents the energy density or content of fat tissue	Hall, 2010; Hall et al., 2009
		RhoL Adolescents coefficient1	4.30	$kcal/kg^2$	This is a constant that represents the coefficient for calculation of fat free body mass energy density	Hall, 2013
		RhoL Adolescents coefficient2	837	kcal/kg	This is a constant that represents the coefficient for calculation of fat free body mass energy density	Hall, 2013

Module	*Sector*	*Parameter*	*Value*	*Unit*	*Comment*	*Source*
		t, age 11	11	Years	This is a constant that represents the time (age) for the calculation of time dependent growth function	Hall, 2013
		t, age 13	13	Years	This is a constant that represents the time (age) for the calculation of time dependent growth function	Hall, 2013
		t, age 15	15	Years	This is a constant that represents the time (age) for the calculation of time dependent growth function	Hall, 2013
		tA, Male	4.7	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood	Hall, 2013
		tA, Female	4.5	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood	Hall, 2013
		TauA, Male	2.5	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood	Hall, 2013
		TauA, Female	1	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood	Hall, 2013
		TauB, Male	1	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood	Hall, 2013
		TauB, Female	0.9	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood	Hall, 2013
		TauD, Male	1.5	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood	Hall, 2013
		TauD, Female	0.7	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood	Hall, 2013
		tB, Male	12.5	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood	Hall, 2013
		tB, Female	11.7	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood	Hall, 2013
		tD, Male	15	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood	Hall, 2013
		tD, Female	16.2	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood	Hall, 2013

Food Environment					
Demand	Attribute Elasticity, Taste	4	Dimensionless	This is a constant that represents the elasticity of food attributes for food. These values are the relative sensitivity of consumers to change in food attributes and they reflect relatively strong sensitivity towards to motivational quality compared to nutritional quality. Elasticity of taste is positive because consumers' behavior towards to change in taste is directly proportional to change in demand or consumption.	Struben et al., 2014
	Attribute Elasticity, Availability	4	Dimensionless	This is a constant that represents the elasticity of food attributes for food. These values are the relative sensitivity of consumers to change in food attributes and they reflect relatively strong sensitivity towards to motivational quality compared to nutritional quality. Elasticity of taste is positive because consumers' behavior towards to change in taste is directly proportional to change in demand or consumption.	Struben et al., 2014
	Attribute Elasticity, Price	-4	Dimensionless	This is a constant that represents the elasticity of food attributes for food. These values are the relative sensitivity of consumers to change in food attributes and they reflect relatively strong sensitivity towards to motivational quality compared to nutritional quality. Elasticity of taste is positive because consumers' behavior towards to change in taste is directly proportional to change in demand or consumption.	Struben et al., 2014
	Education Policy Duration	5	Years	This is a constant that represents how long the policy will be effective.	Parameter value elicited from experts' input during domain experts' workshops
	Exposure Decay	0.35	Dimensionless	This is a constant that represents the limit of decay for familiarity. Above this value, familiarity does not decay	Struben et al., 2014
	HN Education Policy Multiplier	0.10	Dimensionless	This is a constant that represents the magnitude of the policy as an aggregate term that includes political support, commitment of the policy makers, allocation of budget etc.	Parameter value elicited from experts' input during domain experts' workshops
	Normal Familiarity Decay Time	2	Years	This is a constant that represents the time it takes familiarity to decrease	Struben et al., 2014

	Nutritional Quality, High Nutritious	1	Dimensionless	This is a constant that represents the nutritional quality of the food type.	Struben et al., 2014
	Nutritional Quality	1/1.6	Dimensionless	This is a constant that represents the nutritional quality of the food type.	Struben et al., 2014
	Portion Size Policy Duration	5	Years	This is a constant that represents how long the policy will be effective.	Parameter value elicited from experts' input during domain experts' workshops
	Portion Size Policy Multiplier	0.10	Dimensionless	This is a constant that represents the magnitude of the policy as an aggregate term that includes political support, commitment of the policy makers, allocation of budget and etc.	Parameter value elicited from experts' input during domain experts' workshops
	Portion Size INIT	366	kcal/serving	This is a constant that represents the average initial calories per portion	Struben et al., 2014
	Relative importance of familiarity	0.50	dimensionless	This is a constant that represents the weight of familiarity relative to actual affinity in consumer choice	Struben et al., 2014
	Relative importance of nutritional quality INIT	0.70	Dimensionless	This is a constant that represents the importance of the nutritional quality for consumers	Struben et al., 2014
	Education Policy Year	2022	Years	This is a constant that represents the inception year of the policy.	Parameter value elicited from experts' input during domain experts' workshops
	Marketing Policy Year	2022	Years	This is a constant that represents the inception year of the policy.	Parameter value elicited from experts' input during domain experts' workshops
	Meal Servings per day	5	Serving/day/person	This is a constant that represents the number of servings per day per person	Parameter value elicited from experts' input during domain experts' workshops
	Social Exposure Effectiveness	0.10	Dimensionless/year	This is a constant that represents the magnitude of social exposure effectiveness.	Struben et al., 2014
Supply	Attribute Budget Share EXG	1/3	Dimensionless	This parameter represents the portion of allocated budget of each food category and each food attribute. Each attribute has equal share of the budget, initially.	Struben et al., 2014
	Attribute Budget Share INIT	1/3	Dimensionless	This parameter represents the initial portion of the budget of each food category and each food attribute. Each attribute has equal share of the budget, initially.	Struben et al., 2014
	Capabilities INIT, High Nutritious, Taste	1	Dimensionless	This is a constant that represents the initial value of attributes of the food category	Struben et al., 2014

Capabilities INIT, High Nutritious, Availability	1	Dimensionless	This is a constant that represents the initial value of attributes of the food category	Struben et al., 2014
Capabilities INIT, High Nutritious, Price	1	Dimensionless	This is a constant that represents the initial value of attributes of the food category	Struben et al., 2014
Capabilities INIT, Low Nutritious, Taste	1	Dimensionless	This is a constant that represents the initial value of attributes of the food category	Struben et al., 2014
Capabilities INIT, Low Nutritious, Availability	1	Dimensionless	This is a constant that represents the initial value of attributes of the food category	Struben et al., 2014
Capabilities INIT, Low Nutritious, Price	1	Dimensionless	This is a constant that represents the initial value of attributes of the food category	Struben et al., 2014
Category Budget Share EXG, High Nutritious	0.50	Dimensionless	This is a constant that represents the test value for the budget share.	Struben et al., 2014
Category Budget Share EXG, Low Nutritious	0.50	Dimensionless	This is a constant that represents the test value for the budget share.	Struben et al., 2014
Effect of Marketing Policy on Attribute, High Nutritious, Taste	1	Dimensionless	This is a variable that represents the effect of low nutritious food marketing policy on effective attribute value of availability of low nutritious food. Since this policy only influences the availability of low nutritious food, it has no effect on other attributes and food categories.	Parameter value elicited from experts' input during domain experts' workshops
Effect of Marketing Policy on Attribute, High Nutritious, Availability	1	Dimensionless	This is a variable that represents the effect of low nutritious food marketing policy on effective attribute value of availability of low nutritious food. Since this policy only influences the availability of low nutritious food, it has no effect on other attributes and food categories.	Parameter value elicited from experts' input during domain experts' workshops
Effect of Marketing Policy on Attribute, High Nutritious, Price	1	Dimensionless	This is a variable that represents the effect of low nutritious food marketing policy on effective attribute value of availability of low nutritious food. Since this policy only influences the availability of low nutritious food, it	Parameter value elicited from experts' input during domain experts' workshops

			has no effect on other attributes and food categories.	
Effect of Marketing Policy on Attribute, Low Nutritious, Taste	1	Dimensionless	This is a variable that represents the effect of low nutritious food marketing policy on effective attribute value of availability of low nutritious food. Since this policy only influences the availability of low nutritious food, it has no effect on other attributes and food categories.	Parameter value elicited from experts' input during domain experts' workshops
Effect of Marketing Policy on Attribute, Low Nutritious, Price	1	Dimensionless	This is a variable that represents the effect of low nutritious food marketing policy on effective attribute value of availability of low nutritious food. Since this policy only influences the availability of low nutritious food, it has no effect on other attributes and food categories.	Parameter value elicited from experts' input during domain experts' workshops
Effect of Marketing Policy on Attribute, Low Nutritious, Price	1	Dimensionless	This is a variable that represents the effect of low nutritious food marketing policy on effective attribute value of availability of low nutritious food. Since this policy only influences the availability of low nutritious food, it has no effect on other attributes and food categories.	Parameter value elicited from experts' input during domain experts' workshops
Effect of Price Policy on Attribute, High Nutritious, Taste	0	Dimensionless	This is a variable that represents the effect of low nutritious food price policy on effective attribute value of price. Since this policy only influences the price of low nutritious food, it has no effect on other attributes and food categories	Parameter value elicited from experts' input during domain experts' workshops
Effect of Price Policy on Attribute, High Nutritious, Availability	0	Dimensionless	This is a variable that represents the effect of low nutritious food price policy on effective attribute value of price. Since this policy only influences the price of low nutritious food, it has no effect on other attributes and food categories	Parameter value elicited from experts' input during domain experts' workshops
Effect of Price Policy on Attribute, High Nutritious, Price	0	Dimensionless	This is a variable that represents the effect of low nutritious food price policy on effective attribute value of price.	Parameter value elicited from experts' input during domain experts' workshops

			Since this policy only influences the price of low nutritious food, it has no effect on other attributes and food categories	
Effect of Price Policy on Attribute, Low Nutritious, Taste	0	Dimensionless	This is a variable that represents the effect of low nutritious food price policy on effective attribute value of price. Since this policy only influences the price of low nutritious food, it has no effect on other attributes and food categories	Parameter value elicited from experts' input during domain experts' workshops
Effect of Price Policy on Attribute, Low Nutritious, Availability	0	Dimensionless	This is a variable that represents the effect of low nutritious food price policy on effective attribute value of price. Since this policy only influences the price of low nutritious food, it has no effect on other attributes and food categories	Parameter value elicited from experts' input during domain experts' workshops
Effect of Price Policy on Attribute, Low Nutritious, Price	0	Dimensionless	This is a variable that represents the effect of low nutritious food price policy on effective attribute value of price. Since this policy only influences the price of low nutritious food, it has no effect on other attributes and food categories	Parameter value elicited from experts' input during domain experts' workshops
LN Marketing Policy Multiplier	0.10	Dimensionless	This is a constant that represents the magnitude of the policy as an aggregate term that includes political support, commitment of the policy makers, allocation of budget and etc.	Parameter value elicited from experts' input during domain experts' workshops
LN Food Price Policy Multiplier	0.10	Dimensionless	This is a constant that represents the magnitude of the policy as an aggregate term that includes political support, commitment of the policy makers, allocation of budget and etc.	Parameter value elicited from experts' input during domain experts' workshops
Food Policy Year	2022	Years	This is a constant that represents the inception year of the policy.	Parameter value elicited from experts' input during domain experts' workshops
Portion Size Policy Year	2022	Years	This is a constant that represents the inception year of the policy.	Parameter value elicited from experts' input during domain experts' workshops
Price Policy Duration	5	Years	This is a constant that represents how long the policy will be effective.	Parameter value elicited from experts' input during domain experts' workshops

Marketing Policy Duration	5	Years	This is a constant that represents how long the policy will be effective.	Parameter value elicited from experts' input during domain experts' workshops
Initial Attribute, High Nutritious, Taste	0.80	Dimensionless	This is a constant that represents the initial values of food category attributes. It has the assumption that low nutritious food is more available, cheaper, and tastier than the high nutritious food initially.	Struben et al., 2014
Initial Attribute, High Nutritious, Availability	1	Dimensionless	This is a constant that represents the initial values of food category attributes. It has the assumption that low nutritious food is more available, cheaper, and tastier than the high nutritious food initially.	Struben et al., 2014
Initial Attribute, High Nutritious, Price	1	Dimensionless	This is a constant that represents the initial values of food category attributes. It has the assumption that low nutritious food is more available, cheaper, and tastier than the high nutritious food initially.	Struben et al., 2014
Initial Attribute, Low Nutritious, Taste	1.20	Dimensionless	This is a constant that represents the initial values of food category attributes. It has the assumption that low nutritious food is more available, cheaper, and tastier than the high nutritious food initially.	Struben et al., 2014
Initial Attribute, Low Nutritious, Availability	1.20	Dimensionless	This is a constant that represents the initial values of food category attributes. It has the assumption that low nutritious food is more available, cheaper, and tastier than the high nutritious food initially.	Struben et al., 2014
Initial Attribute, Low Nutritious, Price	0.80	Dimensionless	This is a constant that represents the initial values of food category attributes. It has the assumption that low nutritious food is more available, cheaper, and tastier than the high nutritious food initially.	Struben et al., 2014
Learning Exponent, Taste	0.30	Dimensionless	This is a constant that represents the learning curve exponent	Struben et al., 2014
Learning Exponent, Availability	0.30	Dimensionless	This is a constant that represents the learning curve exponent	Struben et al., 2014
Learning Exponent, Price	-0.30	Dimensionless	This is a constant that represents the learning curve exponent	Struben et al., 2014
People	1000	People	This is a constant that represents the number of people engaging in the market.	Struben et al., 2014
Productivity of Investment	0.12	Dimensionless /year	This parameter indicates the assumed productivity that defines the increase rate in capabilities	Struben et al., 2014

	Reference Price	1	NOK/kcal	This is a constant that represents the reference or initial value of price of food for both categories per kilo calories	Struben et al., 2014
	Time to Adjust Budget	1	Years	This is a constant that represents the time it takes to adjust the budget.	Parameter value elicited from experts' input during domain experts' workshops
	Time to Perceive Price	1	Years	This is a constant that represents the time it takes to adjust the budget.	Parameter value elicited from experts' input during domain experts' workshops
Other Calculations	Familiarity High Nutritious INIT	0.60	Dimensionless	This is a constant that represents the initial value of familiarity of consumers with high nutritious food category.	Struben et al., 2014
	Familiarity Low Nutritious INIT	0.90	Dimensionless	This is a constant that represents the initial value of familiarity of consumers with high nutritious food category.	Struben et al., 2014

Physical Activity Environment

Built Environment	Adolescents Fraction in Population	0.10	Dimensionless	This parameter indicates the percentage of the adolescent population.	Parameter value elicited from experts' input during domain experts' workshops
	Built Environment (BE) Density per Thousand Population, Normal	0.70	m^2/People	This parameter indicates the reference value for the proportion of BE available per person.	Parameter value elicited from experts' input during domain experts' workshops
	BE Lifetime	40	Years	This parameter indicates the time in which the built environment decreases its value	Zhou et al., 2019
	BE Usage	3*52	Hours/Year/Person	This parameter represents the rate at which adolescents use Built Environment.	Parameter value elicited from experts' input during domain experts' workshops
	Fraction of BE Density, Normal for BE INIT	1	Dimensionless	This parameter indicates the percentage of normal BE density for BE.	Parameter value elicited from experts' input during domain experts' workshops
	Fraction of BE Density, Normal for Demand	1	Dimensionless	This parameter indicates the percentage of normal BE density for demand.	Parameter value elicited from experts' input during domain experts' workshops
	Normal Fraction of Adolescents to use BE	0.30	Dimensionless	This parameter represents the normal Fraction of adolescents to use BE is the reference percentage of adolescents to use of BE usage of adolescents under normal conditions.	Parameter value elicited from experts' input during domain experts' workshops
	Time to Adjust BE	3	Years	This time constant indicates the time it takes to increase BE.	Parameter value elicited from experts' input

					during domain experts' workshops
	Time to Perceive Demand for BE	3	Years	This parameter indicates the time it takes to adjust BE additions based on its depreciation rate.	Parameter value elicited from experts' input during domain experts' workshops
	Weight of Built Environment, Age 11 to 13, Male	0.30	Dimensionless	This parameter indicates the percentage of male younger adolescents in PA that use BE	Uijtdewilligen et al., 2011; Wiium & Säfvenbom, 2019
	Weight of Built Environment, Age 11 to 13, Female	0.30	Dimensionless	This parameter indicates the percentage of male younger adolescents in PA that use BE	Uijtdewilligen et al., 2011; Wiium & Säfvenbom, 2019
	Weight of Built Environment, Age 13 to 15, Male	0.70	Dimensionless	This parameter indicates the percentage of male younger adolescents in PA that use BE	Uijtdewilligen et al., 2011; Wiium & Säfvenbom, 2019
	Weight of Built Environment, Age 13 to 15, Female	0.70	Dimensionless	This parameter indicates the percentage of male younger adolescents in PA that use BE	Uijtdewilligen et al., 2011; Wiium & Säfvenbom, 2019
Organized Physical Activity	Fraction for Normal Organized PA reductions	0.02	Dimensionless	This parameter represents the normal percentage at which the organized PA activities decay over time.	Parameter value elicited from experts' input during domain experts' workshops
	Fraction of Adolescents in PA Indicated by Social Norm INIT	0.30	Dimensionless	This parameter indicates the initial fraction of adolescents engaged in PA indicated by the PA social norm.	Parameter value elicited from experts' input during domain experts' workshops
	PA Intervention Duration	5	Years	This parameter indicates the baseline PA intervention duration.	Parameter value elicited from experts' input during domain experts' workshops
	Intervention Exposure	0.10	Dimensionless	This parameter indicates the baseline PA intervention magnitude.	Parameter value elicited from experts' input during domain experts' workshops
	Intervention Year	2022	Years	This parameter indicates the year at which the PA policy intervention starts.	Parameter value elicited from experts' input during domain experts' workshops
	Organized PA Supply INIT, Age 11 to 13, Male	0.50	Dimensionless	Initial value of Organized PA supply stock for male adolescents aged 11 to 13	Parameter value elicited from experts' input during domain experts' workshops
	Organized PA Supply INIT, Age 11 to 13, Female	0.50	Dimensionless	Initial value of Organized PA supply stock for female adolescents aged 11 to 13	Parameter value elicited from experts' input during domain experts' workshops

	Organized PA Supply INIT, Age 14 to 15, Male	0.50	Dimensionless	Initial value of Organized PA supply stock for male adolescents aged 14 to 15	Parameter value elicited from experts' input during domain experts' workshops
	Organized PA Supply INIT, Age 14 to 15, Female	0.50	Dimensionless	Initial value of Organized PA supply stock for female adolescents aged 14 to 15	Parameter value elicited from experts' input during domain experts' workshops
	Time to Adjust Fraction of Adolescents in PA from Willingness	3	Years	This parameter indicates the average time it takes to adjust gap between the indicated fraction of adolescents engaged in PA from Motivation and the current Fraction of adolescents in PA from Motivation.	Parameter value elicited from experts' input during domain experts' workshops
	Time to Adjust Organized PA Supply	3	Years	This parameter indicates the average time it takes to adjust Organized PA supply.	Parameter value elicited from experts' input during domain experts' workshops
	Time to Adjust OPA Supply Intervention	2	Years	This parameter indicates the average time it takes to adjust Organized PA supply intervention.	Parameter value elicited from experts' input during domain experts' workshops
	Time to Adjust Exposure to PA	2	Years	This parameter indicates the time it takes for adolescents to adjust their exposure to PA.	Parameter value elicited from experts' input during domain experts' workshops
	Time to Adjust Social Norm	5	Years	This parameter indicates the average time it takes to adjust the social norm regarding PA participation at a population level.	Parameter value elicited from experts' input during domain experts' workshops
	Time to Perceive Demand for Organized PA	3	Years	This parameter indicates the average time it takes to adjust gap between the indicated fraction of adolescents engaged in PA from Motivation and the current Fraction of adolescents in PA from Motivation.	Parameter value elicited from experts' input during domain experts' workshops
	Weight of Social Norm	0.30	Dimensionless	This parameter indicates the weight of the PA social norm that determines the fraction of adolescents in PA indicated by the PA social norm.	Parameter value elicited from experts' input during domain experts' workshops
Propensity to do Physical Activity	Propensity to Engage in PA INIT	0.5	Dimensionless	The initial value of the propensity to engage in PA stock.	Parameter value elicited from experts' input during domain experts' workshops
	Time to Forget Exposure	2	Years	This parameter indicates the time it takes for adolescents to forget their exposure to PA.	Parameter value elicited from experts' input during domain experts' workshops
	Weight of PA Fraction Age 11 to Age 13 in Exposure for	0.2	Dimensionless	This parameter indicates the percentage at which exposure to PA from younger adolescents increase	Parameter value elicited from experts' input during domain experts' workshops

	Age 14 to Age 15		the PA engagement of older adolescents.	
Mental Health				
	Average Time to Modify Self Esteem (SE)	1.2 Years	This constant indicates the time it takes to adjust the indicated self-esteem factor.	Parameter value elicited from experts' input during domain experts' workshops
	Gender Difference, Male, Age 11	0.25 Years	This parameter indicates a differentiating factor separating male and female, where gender differences related to mental wellbeing response can be hypothesized based on qualitative data	Weissman & Olfson, 1995; Bangasser & Valentino, 2014; Kuehner, 2017; Salk et al., 2017; Yu, 2018
	Gender Difference Male, Age 13	0.20 Dimensionless	This parameter indicates a differentiating factor separating male and female, where gender differences related to mental wellbeing response can be hypothesized based on qualitative data	Weissman & Olfson, 1995; Bangasser & Valentino, 2014; Kuehner, 2017; Salk et al., 2017; Yu, 2018
	Gender Difference, Male, Age 15	0.15 Dimensionless	This parameter indicates a differentiating factor separating male and female, where gender differences related to mental wellbeing response can be hypothesized based on qualitative data	Weissman & Olfson, 1995; Bangasser & Valentino, 2014; Kuehner, 2017; Salk et al., 2017; Yu, 2018
	Gender Difference, Female, Age 11	0.60 Dimensionless	This parameter indicates a differentiating factor separating male and female, where gender differences related to mental wellbeing response can be hypothesized based on qualitative data	Weissman & Olfson, 1995; Bangasser & Valentino, 2014; Kuehner, 2017; Salk et al., 2017; Yu, 2018
	Gender Difference Female, Age 13	0.70 Dimensionless	This parameter indicates a differentiating factor separating male and female, where gender differences related to mental wellbeing response can be hypothesized based on qualitative data	Weissman & Olfson, 1995; Bangasser & Valentino, 2014; Kuehner, 2017; Salk et al., 2017; Yu, 2018
	Gender Difference, Female, Age 15	0.80 Dimensionless	This parameter indicates a differentiating factor separating male and female, where gender differences related to mental wellbeing response can be hypothesized based on qualitative data	Weissman & Olfson, 1995; Bangasser & Valentino, 2014; Kuehner, 2017; Salk et al., 2017; Yu, 2018
	Maximum Bullying	5 Dimensionless	This parameter indicates the maximum value defined by the HBSC survey response scales. In this scale, 5 means that the respondents were bullied several times a week.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
	Maximum Computer Overuse	9 Dimensionless	This parameter indicates the maximum value defined by the HBSC survey response scales. In this scale, 9 means that the respondents used computers about 7 or more hours per day.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/

Maximum Mental Wellbeing	5	Dimensionless	This parameter indicates the maximum value defined by the HBSC survey response scales. In this scale, 5 means that the respondents felt mentally well about every day.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Maximum School Pressure	4	Dimensionless	This parameter indicates the maximum value defined by the HBSC survey response scales. In this scale, 4 means that the respondents were pressured by schoolwork a lot.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Maximum Sleep Easiness	5	Dimensionless	This parameter indicates the maximum value defined by the HBSC survey response scales. In this scale, 5 means that the respondents had easiness sleeping about every day.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Maximum Sleep Quality	2	Dimensionless	This parameter indicates the reference value for sleep quality.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Maximum Not Nervousness	5	Dimensionless	This parameter indicates the maximum value defined by the HBSC survey response scales. In this scale, 5 means that the respondents felt not nervous about every day.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Mental Wellbeing, Male, Age 11	4.159	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Mental Wellbeing, Male, Age 13	4.313	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Mental Wellbeing, Male, Age 15	4.304	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Mental Wellbeing, Female, Age 11	3.736	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Mental Wellbeing, Female, Age 13	3.798	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Mental Wellbeing, Female, Age 15	3.603	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/

Normal Not Nervousness, Male, Age 11	4.188	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Not Nervousness, Male, Age 13	4.157	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Not Nervousness, Male, Age 15	4.260	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Not Nervousness, Female, Age 11	3.951	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Not Nervousness, Female, Age 13	3.955	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Not Nervousness, Female, Age 15	3.988	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Sleep Easiness, Male, Age 11	3.910	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Sleep Easiness, Male, Age 13	4.158	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Sleep Easiness, Male, Age 15	4.201	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Sleep Easiness, Female, Age 11	3.650	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Sleep Easiness, Female, Age 13	4.008	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/

			This parameter is arrayed by gender and age group.	
Normal Sleep Easiness, Female, Age 15	3.923	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Stress Level Adjustment Time	1.5	Years	This constant represents the time it takes to adjust psychological stress.	Parameter value elicited from experts' input during domain experts' workshops
Time to Adjust Mental Wellbeing	1.5	Years	This constant represents the time it takes to adjust mental wellbeing.	Parameter value elicited from experts' input during domain experts' workshops
Time to Change Perceived Pressure on Body Image (PPOBI)	1		This constant represents the time it takes to change the perceived pressure on body image.	Parameter value elicited from experts' input during domain experts' workshops
Time to Adjust Sleep Quality	1	Years	This constant represents the time it takes to adjust sleep quality.	Parameter value elicited from experts' input during domain experts' workshops
Time to Change PPOBI	1	Years	This constant represents the time it takes to change the perceived pressure on body image.	Parameter value elicited from experts' input during domain experts' workshops
Computer Overuse, Male, Age 11	3.094	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Computer Overuse, Male, Age 13	3.805	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Computer Overuse, Male, Age 15	4.044	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Computer Overuse, Female, Age 11	2.262	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Computer Overuse, Female, Age 13	2.381	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Computer Overuse, Female, Age 15	2.322	Dimensionless	This parameter indicates the average value defined by the HBSC survey	HBSC, 2002, 2006, 2010, 2018

			responses based on the survey scales. This parameter is arrayed by gender and age group.	https://hbsc.org/data/
Social Norm on Body Image, Male, Age 11	1.10	Dimensionless	This parameter indicates the cultural factor related to a specific ideal body weight. This is a coefficient in the weight bias formulation which can vary according to different contexts. It is arrayed by gender and age group.	Parameter value elicited from experts' input during domain experts' workshops
Social Norm on Body Image, Male, Age 13	1.20	Dimensionless	This parameter indicates the cultural factor related to a specific ideal body weight. This is a coefficient in the weight bias formulation which can vary according to different contexts. It is arrayed by gender and age group.	Parameter value elicited from experts' input during domain experts' workshops
Social Norm on Body Image, Male, Age 15	1.30	Dimensionless	This parameter indicates the cultural factor related to a specific ideal body weight. This is a coefficient in the weight bias formulation which can vary according to different contexts. It is arrayed by gender and age group.	Parameter value elicited from experts' input during domain experts' workshops
Social Norm on Body Image, Female, Age 11	1.10	Dimensionless	This parameter indicates the cultural factor related to a specific ideal body weight. This is a coefficient in the weight bias formulation which can vary according to different contexts. It is arrayed by gender and age group.	Parameter value elicited from experts' input during domain experts' workshops
Social Norm on Body Image, Female, Age 13	1.30	Dimensionless	This parameter indicates the cultural factor related to a specific ideal body weight. This is a coefficient in the weight bias formulation which can vary according to different contexts. It is arrayed by gender and age group.	Parameter value elicited from experts' input during domain experts' workshops
Social Norm on Body Image, Female, Age 15	1.31	Dimensionless	This parameter indicates the cultural factor related to a specific ideal body weight. This is a coefficient in the weight bias formulation which can vary according to different contexts. It is arrayed by gender and age group.	Parameter value elicited from experts' input during domain experts' workshops
School Pressure, Male, Age 11	2.097	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
School Pressure, Male, Age 13	2.160	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
School Pressure, Male, Age 15	2.478	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/

School Pressure, Female, Age 11	2.002	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
School Pressure, Female, Age 13	2.263	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
School Pressure, Female, Age 15	2.650	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Bullying, Male, Age 11	1.739	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group. The association between BMI (body weight) and depressive symptoms (mental health) is significantly mediated by peer victimization (exogenous stressor)	Chang et al. 2017; HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Bullying, Male, Age 13	1.571	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group. The association between BMI (body weight) and depressive symptoms (mental health) is significantly mediated by peer victimization (exogenous stressor)	Chang et al. 2017; HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Bullying, Male, Age 15	1.360	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group. The association between BMI (body weight) and depressive symptoms (mental health) is significantly mediated by peer victimization (exogenous stressor)	Chang et al. 2017; HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Bullying, Female, Age 11	1.737	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group. The association between BMI (body weight) and depressive symptoms (mental health) is significantly	Chang et al. 2017; HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/

			mediated by peer victimization (exogenous stressor)	
Normal Bullying, Female, Age 13	1.372	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group. The association between BMI (body weight) and depressive symptoms (mental health) is significantly mediated by peer victimization (exogenous stressor)	Chang et al. 2017; HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Bullying, Female, Age 15	1.307	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group. The association between BMI (body weight) and depressive symptoms (mental health) is significantly mediated by peer victimization (exogenous stressor)	Chang et al. 2017; HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Average Ideal Body Weight, Male, Age 11	29	kg	This parameter represents the perceived ideal body weight according to specific gender and age group.	Parameter value elicited from experts' input during domain experts' workshops
Average Ideal Body Weight, Male, Age 13	36	kg	This parameter represents the perceived ideal body weight according to specific gender and age group.	Parameter value elicited from experts' input during domain experts' workshops
Average Ideal Body Weight, Male, Age 15	45	kg	This parameter represents the perceived ideal body weight according to specific gender and age group.	Parameter value elicited from experts' input during domain experts' workshops
Average Ideal Body Weight, Female, Age 11	28	kg	This parameter represents the perceived ideal body weight according to specific gender and age group.	Parameter value elicited from experts' input during domain experts' workshops
Average Ideal Body Weight, Female, Age 13	34	kg	This parameter represents the perceived ideal body weight according to specific gender and age group.	Parameter value elicited from experts' input during domain experts' workshops
Average Ideal Body Weight, Female, Age 15	39	kg	This parameter represents the perceived ideal body weight according to specific gender and age group.	Parameter value elicited from experts' input during domain experts' workshops
Maximum Feel Fat	5	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Feet Fat, Male, Age 11	3.043	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/

			This parameter is arrayed by gender and age group.	
Normal Feet Fat, Male, Age 13	3.077	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Feet Fat, Male, Age 15	2.999	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Feet Fat, Female, Age 11	3.158	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Feet Fat, Female, Age 13	3.278	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Normal Feet Fat, Female, Age 15	3.383	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.	HBSC, 2002, 2006, 2010, 2018 https://hbsc.org/data/
Fraction of Mental Mental Wellbeing on Binge Eating	0.80	Dimensionless		Parameter value elicited from experts' input during domain experts' workshops
No Behavior Change	0.10	Dimensionless		Parameter value elicited from experts' input during domain experts' workshops

Initial Values

Table 6 presents the initialization values of the stocks and their sources.

Table 6. Initialization Values of the Model

Module	*Parameter*	*Initial Value*	*Unit*	*Source*
BMI and Population				
	Initial Adolescents per BMI Group, Normal Weight, Male, Age 11	626	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
	Initial Adolescents per BMI Group, Normal Weight, Male, Age 13	655	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
	Initial Adolescents per BMI Group, Normal Weight, Male, Age 15	627	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
	Initial Adolescents per BMI Group, Normal Weight, Female, Age 11	548	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
	Initial Adolescents per BMI Group, Normal Weight, Female, Age 13	689	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
	Initial Adolescents per BMI Group, Normal Weight, Female, Age 15	684	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
	Initial Adolescents per BMI Group, Overweight, Male, Age 11	75	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
	Initial Adolescents per BMI Group, Overweight, Male, Age 13	99	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
	Initial Adolescents per BMI Group, Overweight, Male, Age 15	110	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
	Initial Adolescents per BMI Group, Overweight, Female, Age 11	60	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
	Initial Adolescents per BMI Group, Overweight, Female, Age 13	65	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/

Module	*Parameter*	*Initial Value*	*Unit*	*Source*
	Initial Adolescents per BMI Group, Overweight, Female, Age 15	73	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
	Initial Adolescents per BMI Group, Obese, Male, Age 11	31	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
	Initial Adolescents per BMI Group, Obese, Male, Age 13	32	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
	Initial Adolescents per BMI Group, Obese, Male, Age 15	16	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
	Initial Adolescents per BMI Group, Obese, Female, Age 11	12	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
	Initial Adolescents per BMI Group, Obese, Female, Age 13	9	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
	Initial Adolescents per BMI Group, Obese, Female, Age 15	8	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group based on the HBSC's sample data HBSC, 2002 https://hbsc.org/data/
Food Environment				
	Familiarity with Food Category, HN Food	0.60	Dimensionless	Struben et al., 2014
	Familiarity with Food Category, LN Food	0.90	Dimensionless	Struben et al., 2014
	Capabilities (Taste, Price, Availability arrayed by LN and HN Food)	1	Dimensionless	Struben et al., 2014
Physical Environment				
	Organized PA Supply	0.5	Dimensionless	Parameter value elicited from experts' input during domain experts' workshops
	Propensity to Engage in PA	0.50	Dimensionless	Parameter value elicited from experts' input during domain experts' workshops

Appendix 2. Instructions for Model Use

The model was developed in Stella Architect, version 3.2, hence it requires Stella software for simulation. The model has two files: a model file and a data file. The model file has an *.stmx* extension and the data file has an *.isdb* extension. In order to view and simulate the model for free, Isee Systems Player software is required. With Isee Player, one can view and run the model. Users can download the software from the following link:

https://www.iseesystems.com/softwares/player/iseeplayer.aspx

The model itself is available on and can be downloaded from Github under the following link:

https://github.com/bkopains/Co-Create-mechanism-model

- After installing the software, open the model file. When the model file opens, the following model structure should appear. These boxes are the containers for sub-models mentioned in the report. Double click them to see the actual model structures. Or the model's behaviour can be observed from this level as well. To do this, the mode should run.

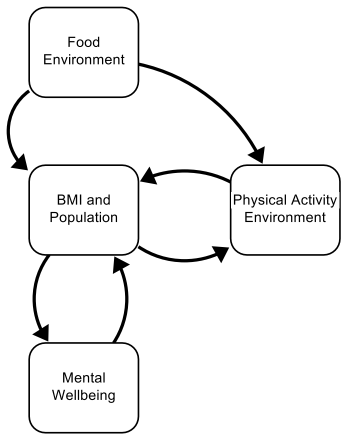


Figure 9. Top Level View of the Model

- **To run the model**, click the ▶ Run Button on the run toolbar appears in the lower left-hand corner of the Isee Player window.
- The model behaviour can be seen in the graph on the right-hand side of the above model structure.
- **To run the model with specific settings**, click *Model* on the menu bar on top of the software window. And navigate to *Run Specs*. A window should pop-up as seen below.

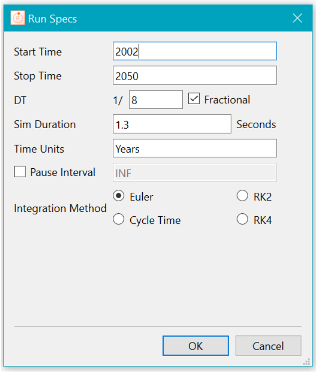


Figure 10. Model Run Specs Window

- **To modify model parameters**, click *Window* on the menu bar and navigate to *Open Parameter Control Panel*. After clicking, a window like seen in the below should appear.

Figure 11. Parameter Control Window

  - On this window, you can either drag and drop variable to the empty area on the window or click ⊕ to add a variable to control. After clicking, a new window should pop-up. With this window, a specific variable can be searched by its name or can be selected from the list by manually.

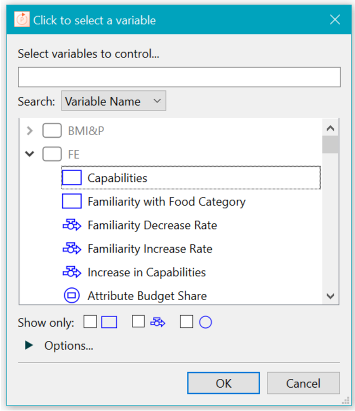


Figure 12. Parameter Search Window

- After a selection is made, the selected variable will appear on the parameter selection window. From this window, values for each parameter can be set by setting the *Value*. All the policy scenarios and sensitivity analyses can be replicated by following the same way.

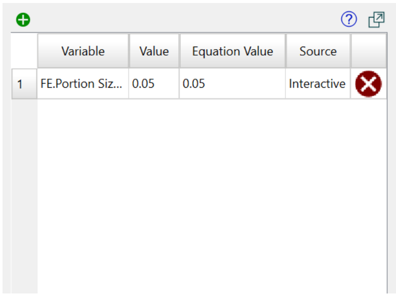


Figure 13. Parameter Control Window After a Selection

- click ✖ to remove a variable
- For Policy Scenarios select:
  - **Policy Year** for setting the year to implement the policy. For example, if 2023 put, the policy will start at year 2023.
  - **Policy Multiplier** for setting the magnitude of the policy which takes a value between 0 and 1. For instance if 0.25 put, it will mean that the so-called policy will have 25% support from the policy makers both in terms for resources and political support
  - **Policy Duration** for setting the time that the policy stays effective. For example, if 10 years put, it will mean that the policy will be implemented for 10 years and then it will stop being effective.
- Similarly, for Sensitivity Analyses
  - Add the parameter to the list and set its sensitivity test value accordingly
- After selecting the parameters and setting their values, click run button to observe the behaviour on the graph comparatively. The base run of the model will be fixed but the consecutive runs will be named after their numbers (i.e., Run 1, Run 2 etc.).

Appendix 3. Report on model review workshop

Introduction

On October 11, 2022, the System Dynamics Group at the University of Bergen hosted a model review workshop to assess the modeling process, review model formulations and discuss next steps to finalize D7.3.

The review panel consisted of:

- On Zoom: Wang Zhao, University of Strathclyde (focus on validation and calibration); Dr. Hugo Herrera, University of Bergen; Brooke Wilkerson, University of Bergen; Dr. Billy Schoenberg, isee systems (focus on calibration and model communication/dissemination)
- In the room, from the University of Bergen: associate professor Saeed Langarudi, Jefferson Rajah, Christina Gkini, Dr. Claudiu Eduard Nedelciu, Kathelijne Bax
- Co-Create project team: Anaely Aguiar, Furkan Onal, Prof. Birgit Kopainsky

The UoB modelling team had sent a comprehensive package of documents to the review panel ahead of the workshop. The package consisted of:

- A text document that introduced Co-Create and the system dynamics modelling work in Co-Create and that described the model purpose and modeling process.
- A presentation that introduced the project, provided an overview of the model, modeling process and validation, walked through the model structure, informed about data and calibration, and presented modelling challenges.
- The actual simulation model and supporting data file that allowed panel members to review the model ahead of the workshop.

Here, we report on the discussions during the model review workshop as well as on the more detailed feedback received in writing from panel members before and after the workshop.

Assessment of the modelling process

The review panel concluded that stakeholder engagement and expert input were sufficient in the modeling process. Given the size of the model, continuous exchange is important for the validity of the model.

The core engine of the model, the Population Weight Change Dynamics Sub-Model, is based on a replication of structures in existing models (Fallah-Fini et al., 2013, 2014; Hall, 2008, 2008, 2010; Hall et al., 2009). Although some of these replications might look complicated, the panel concluded that they are important for the validity of the model.

Mental health processes are of particular importance in the model. The expert workshop in 2021 on this topic was particularly helpful in supporting variables and relationships with evidence and in operationalizing the meaning of mental health. The mental health workshop resulted in the experts initiating a systematic review about mediators of the relationship between variables. The systematic review examined articles about the relationship between mental health, energy-balance related behaviours (i.e., dietary, physical activity and sleep quality) and body weight changes in adolescents. The results from the systematic review have been directly incorporated into the D7.3 model.

Review of model formulations

Specific equations and model structures were revised upon detailed input and suggestions from individual panel members. In general, structures and formulations in the physical activity sector were simplified while structures and formulations in the mental health sector were represented in more operational detail and in a way that they are robust under extreme conditions.

The transient behaviour of OW/OB percentages that were observable at the time of the model review workshop have since been resolved as a result of careful re-calibration. Input by panel members helped identify one of the sources of the transient behavior (issues with total energy intake that have been fixed now).

On a higher level, the panel discussed the generic nature of the model. We concluded that the purpose of the deliverable is a model that is calibrated to one country and that has the potential to be adapted to other countries. The level of aggregation is fairly high and thus fairly generic. E.g., built environment is infrastructure that can be used by the public; aging chains can be calibrated to demographics of other countries; mental health might have some country-specific variables and/or values, but these can be replaced by variables and/or values from other countries.

Discussion of next steps to finalize D7.3

At the time of the model review workshop, sensitivity analysis and detailed calibration had not been completed.

The following suggestions for sensitivity analysis have since been implemented:

- Univariate sensitivity analysis: for all sensitivity parameters, use uniform distributions with parameter ranges of +/-25% of the baseline value, Latin hypercube as sampling method, and 200 runs. Display sensitivity ranges as confidence intervals (or median plus confidence bounds at the end of the simulation horizon, depending on the audience of the publication).
- Global sensitivity analysis: for a combination of 20 to 30 different sensitivity parameters, use Sobol sequencing as sampling method, uniform distributions with parameter ranges of +/-25% of the baseline value, and up to 100.000 runs to explore the full uncertainty range of the model. Display sensitivity ranges as confidence intervals (or median plus confidence bounds at the end of the simulation horizon, depending on the audience of the publication).
- Policy sensitivity analysis: For each policy scenario, the same global sensitivity analysis needs to be run as under baseline conditions.

The following suggestions for calibration have since been implemented:

- The method used for calibration in Stella Architect is gradient descent optimizer, BOBYQA. This is important for planned publications.
- The method works best with randomized additional starts (fewer than 10 additional starts).
- If those additional starts yield significantly different parameter sets, the use of Markov Chain Monte Carlo simulation needs to be considered. In the simulations conducted until the publication of D7.3, this has not been an issue.

The panel also discussed the use of optimization with uncertainty for policy analysis but concluded that the model is better suited for exploring the role of feedback loops and their interactions as well as the nature of different leverage points than to optimize across potential policy scenarios.

Appendix 4. Model Documentation

Variable Type	Variable Name	Equation	Unit	Description
BMI and Population				
Aging Chain				
	Inflow to BMI Bin from Above A11, Normal Weight, Male	Outflow from BMI Bin Down A11, Overweight, Male	People/Years	This flow indicates the rate of male adolescents aged 11 that transition from Overweight to Normal weight.
	Inflow to BMI Bin from Above A11, Normal Weight, Female	Outflow from BMI Bin Down A11, Overweight, Female	People/Years	This flow indicates the rate of female adolescents aged 11 that transition from Overweight to Normal weight.
	Inflow to BMI Bin from Above A11, Overweight, Male	Outflow from BMI Bin Down A11, Obese, Male	People/Years	This flow indicates the rate of male adolescents aged 11 that transition from Obese to Overweight.
	Inflow to BMI Bin from Above A11, Overweight, Female	Outflow from BMI Bin Down A11, Obese, Female	People/Years	This flow indicates the rate of female adolescents aged 11 that transition from Obese to Overweight.
	Inflow to BMI Bin from Above A11, Obese, Male	0	People/Years	The value of this flow is always zero because there is no BMI group above Obese in the model
	Inflow to BMI Bin from Above A11, Obese, Female	0	People/Years	The value of this flow is always zero because there is no BMI group above Obese in the model
	Inflow to BMI Bin from Above A13, Normal Weight, Male	Outflow from BMI Bin Down A13, Overweight, Male	People/Years	This flow indicates the rate of male adolescents aged 13 that transition from Overweight to Normal Weight
	Inflow to BMI Bin from Above A13, Normal Weight, Female	Outflow from BMI Bin Down A13, Overweight, Female	People/Years	This flow indicates the rate of female adolescents aged 13 that transition from Overweight to Normal Weight
	Inflow to BMI Bin from Above A13, Overweight, Male	Outflow from BMI Bin Down A13, Obese, Male	People/Years	This flow indicates the rate of male adolescents aged 13 that transition from Obese to Overweight
	Inflow to BMI Bin from Above A13, Overweight, Female	Outflow from BMI Bin Down A13, Obese, Female	People/Years	This flow indicates the rate of female adolescents aged 13 that transition from Obese to Overweight
	Inflow to BMI Bin from Above A13, Obese, Male	0	People/Years	The value of this flow is always zero because there is no BMI group above Obese in the model
	Inflow to BMI Bin from Above A13, Obese, Female	0	People/Years	The value of this flow is always zero because there is no BMI group above Obese in the model
	Inflow to BMI Bin from Above A15, Normal Weight, Male	Outflow from BMI Bin Down A15, Overweight, Male	People/Years	This flow indicates the rate of male adolescents aged 15 that transition from Overweight to Normal weight

Variable Type	Variable Name	Equation	Unit	Description
	Inflow to BMI Bin from Above A15, Normal Weight, Female	Outflow from BMI Bin Down A15, Overweight, Female	People/Years	This flow indicates the rate of female adolescents aged 15 that transition from Overweight to Normal weight
	Inflow to BMI Bin from Above A15, Overweight, Male	Outflow from BMI Bin Down A15, Obese, Male	People/Years	This flow indicates the rate of male adolescents aged 15 that transition from Obese to Overweight
	Inflow to BMI Bin from Above A15, Overweight, Female	Outflow from BMI Bin Down A15, Obese, Female	People/Years	This flow indicates the rate of female adolescents aged 15 that transition from Obese to Overweight
	Inflow to BMI Bin from Above A15, Obese, Male	0	People/Years	The value of this flow is always zero because there is no BMI group above Obese in the model
	Inflow to BMI Bin from Above A15, Obese, Female	0	People/Years	The value of this flow is always zero because there is no BMI group above Obese in the model
	Inflow to BMI Bin from Below A11, Normal Weight, Male	0	People/Years	The value of this flow is always zero because there is no BMI group below Normal Weight in the model
	Inflow to BMI Bin from Below A11, Normal Weight, Female	0	People/Years	The value of this flow is always zero because there is no BMI group below Normal Weight in the model
	Inflow to BMI Bin from Below A11, Overweight, Male	Outflow from BMI Bin Up A11, Normal Weight, Male	People/Years	This flow indicates the rate of male adolescents aged 11 that transition from Normal Weight to Overweight
	Inflow to BMI Bin from Below A11, Overweight, Female	Outflow from BMI Bin Up A11, Normal Weight, Female	People/Years	This flow indicates the rate of female adolescents aged 11 that transition from Normal Weight to Overweight
	Inflow to BMI Bin from Below A11, Obese, Male	Outflow from BMI Bin Up A11, Overweight, Male	People/Years	This flow indicates the rate of male adolescents aged 11 that transition from Overweight to Obese
	Inflow to BMI Bin from Below A11, Obese, Female	Outflow from BMI Bin Up A11, Overweight, Female	People/Years	This flow indicates the rate of female adolescents aged 11 that transition from Overweight to Obese
	Inflow to BMI Bin from Below A13, Normal Weight, Male	0	People/Years	The value of this flow is always zero because there is no BMI group below Normal Weight in the model
	Inflow to BMI Bin from Below A13, Normal Weight, Female	0	People/Years	The value of this flow is always zero because there is no BMI group below Normal Weight in the model
	Inflow to BMI Bin from Below A13, Overweight, Male	Outflow from BMI Bin Up A13, Normal Weight, Male	People/Years	This flow indicates the rate of male adolescents aged 13 that transition from Normal Weight to Overweight
	Inflow to BMI Bin from Below A13, Overweight, Female	Outflow from BMI Bin Up A13, Normal Weight, Female	People/Years	This flow indicates the rate of female adolescents aged 13 that transition from Normal Weight to Overweight
	Inflow to BMI Bin from Below A13, Obese, Male	Outflow from BMI Bin Up A13, Overweight, Male	People/Years	This flow indicates the rate of male adolescents aged 13 that transition from Overweight to Obese

Variable Type	Variable Name	Equation	Unit	Description
	Inflow to BMI Bin from Below A13, Obese, Female	Outflow from BMI Bin Up A13, Overweight, Female	People/Years	This flow indicates the rate of female adolescents aged 13 that transition from Overweight to Obese
	Inflow to BMI Bin from Below A15, Normal Weight, Male	0	People/Years	The value of this flow is always zero because there is no BMI group below Normal Weight in the model
	Inflow to BMI Bin from Below A15, Normal Weight, Female	0	People/Years	The value of this flow is always zero because there is no BMI group below Normal Weight in the model
	Inflow to BMI Bin from Below A15, Overweight, Male	Outflow from BMI Bin Up A15, Normal Weight, Male	People/Years	This flow indicates the rate of male adolescents aged 15 that transition from Normal Weight to Overweight
	Inflow to BMI Bin from Below A15, Overweight, Female	Outflow from BMI Bin Up A15, Normal Weight, Female	People/Years	This flow indicates the rate of female adolescents aged 15 that transition from Normal Weight to Overweight
	Inflow to BMI Bin from Below A15, Obese, Male	Outflow from BMI Bin Up A15, Overweight, Male	People/Years	This flow indicates the rate of male adolescents aged 15 that transition from Overweight to Obese
	Inflow to BMI Bin from Below A15, Obese, Female	Outflow from BMI Bin Up A15, Overweight, Female	People/Years	This flow indicates the rate of female adolescents aged 15 that transition from Overweight to Obese
	INIT adolescents per BMI Group, Normal Weight, Male, Age 11	626	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (normal weight, male, age 11) based on the Health Behavior in School-aged Children (HBSC)'s sample data (World Health Organization , WHO, 2022)
	INIT adolescents per BMI Group, Normal Weight, Male, Age 13	655	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (normal weight, male, age 13) based on the HBSC's sample data (WHO, 2022).
	INIT adolescents per BMI Group, Normal Weight, Male, Age 15	627	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (normal weight, male, age 15) based on the HBSC's sample data (WHO, 2022).
	INIT adolescents per BMI Group, Normal Weight, Female, Age 11	548	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (normal weight, female, age 11) based on the HBSC's sample data (WHO, 2022).
	INIT adolescents per BMI Group, Normal Weight, Female, Age 13	689	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (normal weight, female, age 13) based on the HBSC's sample data (WHO, 2022).
	INIT adolescents per BMI Group, Normal Weight, Female, Age 15	684	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (normal weight, female, age 15)

Variable Type	Variable Name	Equation	Unit	Description
				based on the HBSC's sample data (WHO, 2022).
	INIT adolescents per BMI Group, Overweight, Male, Age 11	75	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (overweight, male, age 11) based on the HBSC's sample data (WHO, 2022).
	INIT adolescents per BMI Group, Overweight, Male, Age 13	99	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (overweight, male, age 13) based on the HBSC's sample data (WHO, 2022).
	INIT adolescents per BMI Group, Overweight, Male, Age 15	110	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (overweight, male, age 15) based on the HBSC's sample data (WHO, 2022).
	INIT adolescents per BMI Group, Overweight, Female, Age 11	60	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (overweight, female, age 11) based on the HBSC's sample data (WHO, 2022).
	INIT adolescents per BMI Group, Overweight, Female, Age 13	65	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (overweight, female, age 13) based on the HBSC's sample data (WHO, 2022).
	INIT adolescents per BMI Group, Overweight, Female, Age 15	73	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (overweight, female, age 15) based on the HBSC's sample data (WHO, 2022).
	INIT adolescents per BMI Group, Obese, Male, Age 11	31	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (obese, male, age 11) based on the HBSC's sample data (WHO, 2022).
	INIT adolescents per BMI Group, Obese, Male, Age 13	32	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (obese, male, age 13) based on the HBSC's sample data (WHO, 2022).
	INIT adolescents per BMI Group, Obese, Male, Age 15	16	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (obese, male, age 15) based on the HBSC's sample data (WHO, 2022).
	INIT adolescents per BMI Group, Obese, Female, Age 11	12	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (obese, female, age 11) based on the HBSC's sample data (WHO, 2022).
	INIT adolescents per BMI Group, Obese, Female, Age 13	9	People	Initial value of number of adolescents arrayed by BMI group, gender, and age group (obese, female, age 13) based on the HBSC's sample data (WHO, 2022).
	INIT adolescents per BMI Group, Obese, Female, Age 15	8	People	Initial value of number of adolescents arrayed by BMI group, gender, and age

Variable Type	Variable Name	Equation	Unit	Description
				group (obese, female, age 15) based on the HBSC's sample data (WHO, 2022).
	maturation A10 to A11, BMI Group, Gender	INIT adolescents per BMI Group, BMI Group, Gender, Age 11/Maturation time A10 to A11	People/Years	This inflow calculates the rate of adolescents maturing from 10yo to 11yo, entering the aging chain after a delay equal to the maturation time. It is calculated by dividing the initial value of adolescents according to their BMI group, gender and age group based on the HBSC data sample size, into the maturation time A10 to A11
	maturation A11 to A13, BMI Group, Gender	MIN(Population Age 11, Population Age 11/Maturation Time Youth)	People/Years	This flow calculates the rate of adolescents maturing from 11yo to 13yo moving to the next age cohort after a delay equal to maturation time. It is calculated by dividing the value of the stock of the population Age 11 into the maturation time of Youth.
	maturation A13 to A15, BMI Group, Gender	MIN(Population Age 13, Population Age 13/Maturation Time Youth)	People/Years	This flow calculates the rate of adolescents maturing from 13yo to 15yo moving to the next age cohort after a delay equal to the maturation time. It is calculated by dividing the value of the stock of the population Age 13 into the maturation time of Youth.
	maturation A15 to A16, BMI Group, Gender	MIN(Population Age 15, Population Age 15/Maturation Time Youth to exit the aging chain)	People/Years	This flow calculates the rate of adolescents maturing from 15yo to 17yo exiting the aging chain after a delay equal to the maturation time. It is calculated by dividing the value of the stock of the population Age 15 into the maturation time of Youth to exit the aging chain.
	Maturation time A10 to 11	2	Years	This parameter represents the time it takes for adolescents to mature and enter the aging chain.
	Maturation Time Youth	2	Years	This parameter represents the time it takes for adolescents to mature and move to the next age cohort in the aging chain.
	Maturation Time Youth to exit the aging chain	2	Years	This parameter represents the time it takes for adolescents to mature and exit the aging chain when they turn 17 years old.
	Outflow to BMI Bin Down A11, Normal Weight, Male	MIN(Population Age 11, Normal Weight, Male, Leaving Down Rate, Normal Weight, Male, Age 11)	People/Years	The value of this flow is always zero because there is no BMI group below Normal Weight in the model. It is calculated by the rate of male adolescents aged 11leaving the Normal Weight BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 11 stock.
	Outflow to BMI Bin Down A11, Normal Weight, Female	MIN(Population Age 11, Normal Weight, Female, Leaving Down Rate, Normal Weight, Female, Age 11)	People/Years	The value of this flow is always zero because there is no BMI group below Normal Weight in the model. It is calculated by the rate of female

Variable Type	Variable Name	Equation	Unit	Description
				adolescents aged 11 leaving the Normal Weight BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 11 stock.
	Outflow to BMI Bin Down A11, Overweight, Male	MIN(Population Age 11, Overweight, Male, Leaving Down Rate, Overweight, Male, Age 11)	People/Years	This is the rate of male adolescents aged 11 that transition from Overweight to Normal Weight. It is calculated by the rate of male adolescents leaving the Overweight BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 11 stock.
	Outflow to BMI Bin Down A11, Overweight, Female	MIN(Population Age 11, Overweight, Female, Leaving Down Rate, Overweight, Female, Age 11)	People/Years	This is the rate of female adolescents aged 11 that transition from Overweight to Normal Weight. It is calculated by the rate of male adolescents leaving the Overweight BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 11 stock.
	Outflow to BMI Bin Down A11, Obese, Male	MIN(Population Age 11, Obese, Male, Leaving Down Rate, Obese, Male, Age 11)	People/Years	This is the rate of male adolescents aged 11 that transition from Obese to Overweight. It is calculated by the rate of male adolescents leaving the Obese BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 11 stock.
	Outflow to BMI Bin Down A11, Obese, Female	MIN(Population Age 11, Obese, Female, Leaving Down Rate, Obese, Female, Age 11)	People/Years	This is the rate of female adolescents aged 11 that transition from Obese to Overweight. It is calculated by the rate of male adolescents leaving the Obese BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 11 stock.
	Outflow to BMI Bin Down A13, Normal Weight, Male	MIN(Population Age 13, Normal Weight, Male, Leaving Down Rate, Normal Weight, Male, Age 13)	People/Years	The value of this flow is always zero because there is no BMI group below Normal Weight in the model. It is calculated by the rate of male adolescents aged 13 leaving the Normal Weight BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 13 stock.
	Outflow to BMI Bin Down A13, Normal Weight, Female	MIN(Population Age 13, Normal Weight, Female, Leaving Down Rate, Normal Weight, Female, Age 13)	People/Years	The value of this flow is always zero because there is no BMI group below Normal Weight in the model. It is calculated by the rate of female adolescents aged 13 leaving the Normal Weight BMI group to a BMI group below and constrained by the number of

Variable Type	Variable Name	Equation	Unit	Description
				adolescents available in the Population Age 13 stock.
	Outflow to BMI Bin Down A13, Overweight, Male	MIN(Population Age 13, Overweight, Male, Leaving Down Rate, Overweight, Male, Age 13)	People/Years	This is the rate of male adolescents aged 13 that transition from Overweight to Normal Weight. It is calculated by the rate of male adolescents leaving the Overweight BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 13 stock.
	Outflow to BMI Bin Down A13, Overweight, Female	MIN(Population Age 13, Overweight, Female, Leaving Down Rate, Overweight, Female, Age 13)	People/Years	This is the rate of female adolescents aged 13 that transition from Overweight to Normal Weight. It is calculated by the rate of male adolescents leaving the Overweight BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 13 stock.
	Outflow to BMI Bin Down A13, Obese, Male	MIN(Population Age 13, Obese, Male, Leaving Down Rate, Obese, Female, Age 13)	People/Years	This is the rate of male adolescents aged 13 that transition from Obese to Overweight. It is calculated by the rate of male adolescents leaving the Obese BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 13 stock.
	Outflow to BMI Bin Down A13, Obese, Female	MIN(Population Age 13, Obese, Female, Leaving Down Rate, Obese, Female, Age 13)	People/Years	This is the rate of female adolescents aged 13 that transition from Obese to Overweight. It is calculated by the rate of male adolescents leaving the Obese BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 13 stock.
	Outflow to BMI Bin Down A15, Normal Weight, Male	MIN(Population Age 15, Normal Weight, Male, Leaving Down Rate, Normal Weight, Male, Age 15)	People/Years	The value of this flow is always zero because there is no BMI group below Normal Weight in the model. It is calculated by the rate of male adolescents aged 15 leaving the Normal Weight BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 15 stock.
	Outflow to BMI Bin Down A15, Normal Weight, Female	MIN(Population Age 15, Normal Weight, Female, Leaving Down Rate, Normal Weight, Female, Age 15)	People/Years	The value of this flow is always zero because there is no BMI group below Normal Weight in the model. It is calculated by the rate of female adolescents aged 15 leaving the Normal Weight BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 15 stock.

Variable Type	Variable Name	Equation	Unit	Description
	Outflow to BMI Bin Down A15, Overweight, Male	MIN(Population Age 15, Overweight, Male, Leaving Down Rate, Overweight, Male, Age 15)	People/Years	This is the rate of male adolescents aged 15 that transition from Overweight to Normal Weight. It is calculated by the rate of male adolescents leaving the Overweight BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 15 stock.
	Outflow to BMI Bin Down A15, Overweight, Female	MIN(Population Age 15, Overweight, Female, Leaving Down Rate, Overweight, Female, Age 15)	People/Years	This is the rate of female adolescents aged 15 that transition from Overweight to Normal Weight. It is calculated by the rate of male adolescents leaving the Overweight BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 15 stock.
	Outflow to BMI Bin Down A15, Obese, Male	MIN(Population Age 15, Obese, Male, Leaving Down Rate, Obese, Male, Age 15)	People/Years	This is the rate of male adolescents aged 15 that transition from Obese to Overweight. It is calculated by the rate of male adolescents leaving the Obese BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 15 stock.
	Outflow to BMI Bin Down A15, Obese, Female	MIN(Population Age 15, Obese, Female, Leaving Down Rate, Obese, Female, Age 15)	People/Years	This is the rate of female adolescents aged 15 that transition from Obese to Overweight. It is calculated by the rate of male adolescents leaving the Obese BMI group to a BMI group below and constrained by the number of adolescents available in the Population Age 15 stock.
	Outflow to BMI Bin Up A11, Normal Weight, Male	MIN(Population Age 11, Normal Weight, Male, Leaving Up Rate, Normal Weight, Male, Age 11)	People/Years	This is the rate of male adolescents aged 11 that transition from Normal Weight to Overweight. It is calculated by the rate of male adolescents leaving the Normal Weight BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 11 stock.
	Outflow to BMI Bin Up A11, Normal Weight, Female	MIN(Population Age 11, Normal Weight, Female, Leaving Up Rate, Normal Weight, Female, Age 11)	People/Years	This is the rate of female adolescents aged 11 that transition from Normal Weight to Overweight. It is calculated by the rate of male adolescents leaving the Normal Weight BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 11 stock.
	Outflow to BMI Bin Up A11, Overweight, Male	MIN(Population Age 11, Overweight, Male, Leaving Up Rate, Overweight, Male, Age 11)	People/Years	This is the rate of male adolescents aged 11 that transition from Overweight to Obese. It is calculated by the rate of male adolescents leaving the Overweight BMI

Variable Type	Variable Name	Equation	Unit	Description
				group to a BMI group above and constrained by the number of adolescents available in the Population Age 11 stock.
	Outflow to BMI Bin Up A11, Overweight, Female	MIN(Population Age 11, Overweight, Female, Leaving Up Rate, Overweight, Female, Age 11)	People/Years	This is the rate of female adolescents aged 11 that transition from Overweight to Obese. It is calculated by the rate of male adolescents leaving the Overweight BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 11 stock.
	Outflow to BMI Bin Up A11, Obese, Male	MIN(Population Age 11, Obese, Male, Leaving Up Rate, Obese, Male, Age 11)	People/Years	The value of this flow is always zero because there is no BMI group above Obese in the model. It is calculated by the rate of male adolescents aged 11 leaving the Obese BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 11 stock.
	Outflow to BMI Bin Up A11, Obese, Female	MIN(Population Age 11, Obese, Female, Leaving Up Rate, Obese, Female, Age 11)	People/Years	The value of this flow is always zero because there is no BMI group above Obese in the model. It is calculated by the rate of female adolescents aged 11 leaving the Obese BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 11 stock.
	Outflow to BMI Bin Up A13, Normal Weight, Male	MIN(Population Age 13, Normal Weight, Male, Leaving Up Rate, Normal Weight, Male, Age 13)	People/Years	This is the rate of male adolescents aged 13 that transition from Normal Weight to Overweight. It is calculated by the rate of male adolescents leaving the Normal Weight BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 13 stock.
	Outflow to BMI Bin Up A13, Normal Weight, Female	MIN(Population Age 13, Normal Weight, Female, Leaving Up Rate, Normal Weight, Female, Age 13)	People/Years	This is the rate of male adolescents aged 13 that transition from Normal Weight to Overweight. It is calculated by the rate of female adolescents leaving the Normal Weight BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 13 stock.
	Outflow to BMI Bin Up A13, Overweight, Male	MIN(Population Age 13, Overweight, Male, Leaving Up Rate, Overweight, Male, Age 13)	People/Years	This is the rate of male adolescents aged 13 that transition from Overweight to Obese. It is calculated by the rate of male adolescents leaving the Overweight BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 13 stock.

Variable Type	Variable Name	Equation	Unit	Description
	Outflow to BMI Bin Up A13, Overweight, Female	MIN(Population Age 13, Overweight, Female, Leaving Up Rate, Overweight, Female, Age 13)	People/Years	This is the rate of male adolescents aged 13 that transition from Overweight to Obese. It is calculated by the rate of female adolescents leaving the Overweight BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 13 stock.
	Outflow to BMI Bin Up A13, Obese, Male	MIN(Population Age 13, Obese, Male, Leaving Up Rate, Obese, Male, Age 13)	People/Years	The value of this flow is always zero because there is no BMI group above Obese in the model. It is calculated by the rate of male adolescents aged 13 leaving the Obese BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 13 stock.
	Outflow to BMI Bin Up A13, Obese, Female	MIN(Population Age 13, Obese, Female, Leaving Up Rate, Obese, Female, Age 13)	People/Years	The value of this flow is always zero because there is no BMI group above Obese in the model. It is calculated by the rate of female adolescents aged 13 leaving the Obese BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 13 stock.
	Outflow to BMI Bin Up A15, Normal Weight, Male	MIN(Population Age 15, Normal Weight, Male, Leaving Up Rate, Normal Weight, Male, Age 15)	People/Years	This is the rate of male adolescents aged 15 that transition from Normal Weight to Overweight. It is calculated by the rate of male adolescents leaving the Normal Weight BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 15 stock.
	Outflow to BMI Bin Up A15, Normal Weight, Female	MIN(Population Age 15, Normal Weight, Female, Leaving Up Rate, Normal Weight, Female, Age 15)	People/Years	This is the rate of male adolescents aged 15 that transition from Normal Weight to Overweight. It is calculated by the rate of female adolescents leaving the Normal Weight BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 15 stock.
	Outflow to BMI Bin Up A15, Overweight, Male	MIN(Population Age 15, Overweight, Male, Leaving Up Rate, Overweight, Male, Age 15)	People/Years	This is the rate of male adolescents aged 15 that transition from Overweight to Obese. It is calculated by the rate of male adolescents leaving the Overweight BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 15 stock.
	Outflow to BMI Bin Up A15, Overweight, Female	MIN(Population Age 15, Overweight, Female, Leaving Up Rate, Overweight, Female, Age 15)	People/Years	This is the rate of male adolescents aged 15 that transition from Overweight to Obese. It is calculated by the rate of female adolescents leaving the Overweight

Variable Type	Variable Name	Equation	Unit	Description
				BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 15 stock.
	Outflow to BMI Bin Up A15, Obese, Male	MIN(Population Age 15, Obese, Male, Leaving Up Rate, Obese, Male, Age 15)	People/Years	The value of this flow is always zero because there is no BMI group above Obese in the model. It is calculated by the rate of male adolescents aged 15 leaving the Obese BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 15 stock.
	Outflow to BMI Bin Up A15, Obese, Female	MIN(Population Age 15, Obese, Female, Leaving Up Rate, Obese, Female, Age 15)	People/Years	The value of this flow is always zero because there is no BMI group above Obese in the model. It is calculated by the rate of female adolescents aged 15 leaving the Obese BMI group to a BMI group above and constrained by the number of adolescents available in the Population Age 15 stock.
	Population Age 11, BMI Group, Gender(t)	Population Age 11, BMI Group, Gender(t - dt) + (maturation A10 to A11, BMI Group, Gender + Inflow to BMI Bin from Below, BMI Group, Gender + Inflow to BMI Bin from Above, BMI Group, Gender - maturation A11 to A13, BMI Group, Gender - Outflow from BMI Bin Up A11, BMI Group, Gender - Outflow from BMI Bin Down A11, BMI Group, Gender) * dt	People	This is a stock variable that calculates the number of adolescents at each point in time. It is accumulated by integrated difference between the inflows maturation rate A10 to A11, the inflow to BMI bin from category below, the inflow to BMI bin from category above and the outflows maturation rate A11 to A13, outflow to BMI Bin Up, outflow to BMI Bin down. This stock is arrayed by BMI categories and gender. The initial value of the stock is adolescents aged 11 based on the HBSC data sample size.
	Population Age 13, BMI Group, Gender(t)	Population Age 13, BMI Group, Gender(t - dt) + (Inflow to BMI Bin from Below A13, BMI Group, Gender + Inflow to BMI Bin from Above A13, BMI Group, Gender + maturation A11 to A13, BMI Group, Gender - maturation A13 to A15, BMI Group, Gender - Outflow from BMI Bin Up A13, BMI Group, Gender - Outflow from BMI Bin Down A13, BMI Group, Gender) * dt	People	This is a stock variable that calculates the number of adolescents at each point in time. It is accumulated by integrated difference between the inflows maturation rate A11 to A13, the inflow to BMI bin from category below, the inflow to BMI bin from category above and the outflows maturation rate A13 to A15, outflow to BMI Bin Up, outflow to BMI Bin down. This stock is arrayed by BMI categories and gender. The initial value of the stock is adolescents aged 13 based on the HBSC data sample size
	Population Age 15, BMI Group, Gender(t)	Population Age 15, BMI Group, Gender(t - dt) + (Inflow to BMI Bin from Below A15, BMI Group, Gender + Inflow to BMI Bin from Above A15, BMI Group, Gender + maturation A13 to A15, BMI Group, Gender - maturation A15 to A16, BMI	People	This is a stock variable that calculates the number of adolescents at each point in time. It is accumulated by integrated difference between the inflows maturation rate A13 to A15, the inflow to BMI bin

Variable Type	Variable Name	Equation	Unit	Description
		Group, Gender - Outflow from BMI Bin Up A15, BMI Group, Gender - Outflow from BMI Bin Down A15, BMI Group, Gender) * dt		from category below, the inflow to BMI bin from category above and the outflows maturation rate A15 to A17, outflow to BMI Bin Up, outflow to BMI Bin down. This stock is arrayed by BMI categories and gender. The initial value of the stock is adolescents aged 15 based on the HBSC data sample size.
BMI Distribution				
○	BMI Coefficient for FM Fraction Reference	1.51	(meter*meter)/kg	This parameter is the associated coefficient that multiplies the BMI representative value in the FM fraction reference equation (Cortes-Castell et al., 2017).
○	BMI Representative, BMI Group, Gender, Age Group	Xinit+(Xfin-Xinit)/2	kg/(meter*meter)	This variable calculates the BMI of the representative individual. It is calculated by the average of the initial and final values of BMI range for the population groups plus its initial value resulting in a middle point between the initial and the final values (Fallah-fini et al., 2013). It is arrayed by BMI group, gender and age group.
○	BW Representative, BMI Group, Gender, Age Group	BMI Representative, BMI Group, Gender, Age Group*Height, Gender, Age Group*Height, Gender, Age Group	kg	This variable represents the body weight of the representative individual in each population group. It is calculated by multiplying the BMI of the representative individual by the square of height of the representative individual (Fallah-fini et al., 2013).
○	Distance Xfin to representative Own, BMI Group, Gender, Age Group	Xfin-BMI Representative	kg/(meter*meter)	This variable calculates how much the representative individual differs from the final point of the range to which the representative individual belongs to (Fallah-fini et al., 2013).
○	Distance Xfin to representative Up, Normal Weight, Male, Age 11	BMI Representative, Overweight, Male, Age 11-Xfin, Normal Weight, Male, Age 11	kg/(meter*meter)	This variable calculates how much the representative male individual aged 11 differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013).
○	Distance Xfin to representative Up, Normal Weight, Male, Age 13	BMI Representative, Overweight, Male, Age 13-Xfin, Normal Weight, Male, Age 13	kg/(meter*meter)	This variable calculates how much the representative male individual aged 13 differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013).

Variable Type	Variable Name	Equation	Unit	Description
◯	Distance Xfin to representative Up, Normal Weight, Male, Age 15	BMI Representative, Overweight, Male, Age 15-Xfin, Normal Weight, Male, Age 15	kg/(meter*meter)	This variable calculates how much the representative male individual aged 15 differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013).
◯	Distance Xfin to representative Up, Normal Weight, Female, Age 11	BMI Representative, Overweight, Female, Age 11-Xfin, Normal Weight, Female, Age 11	kg/(meter*meter)	This variable calculates how much the representative female individual aged 11 differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013).
◯	Distance Xfin to representative Up, Normal Weight, Female, Age 13	BMI Representative, Overweight, Female, Age 13-Xfin, Normal Weight, Female, Age 13	kg/(meter*meter)	This variable calculates how much the representative female individual aged 13 differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013).
◯	Distance Xfin to representative Up, Normal Weight, Female, Age 15	BMI Representative, Overweight, Female, Age 15-Xfin, Normal Weight, Female, Age 15	kg/(meter*meter)	This variable calculates how much the representative female individual aged 15 differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013).
◯	Distance Xfin to representative Up, Overweight, Male, Age 11	BMI Representative, Obese, Male, Age 11-Xfin, Overweight, Male, Age 11	kg/(meter*meter)	This variable calculates how much the representative male individual aged 11 differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013).
◯	Distance Xfin to representative Up, Overweight, Male, Age 13	BMI Representative, Obese, Male, Age 13-Xfin, Overweight, Male, Age 13	kg/(meter*meter)	This variable calculates how much the representative male individual aged 13 differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013).
◯	Distance Xfin to representative Up, Overweight, Male, Age 15	BMI Representative, Obese, Male, Age 15-Xfin, Overweight, Male, Age 15	kg/(meter*meter)	This variable calculates how much the representative male individual aged 15 differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013).
◯	Distance Xfin to representative Up, Overweight, Female, Age 11	BMI Representative, Obese, Female, Age 11-Xfin, Overweight, Female, Age 11	kg/(meter*meter)	This variable calculates how much the representative female individual aged 11 differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013).
◯	Distance Xfin to representative Up, Overweight, Female, Age 13	BMI Representative, Obese, Female, Age 13-Xfin, Overweight, Female, Age 13	kg/(meter*meter)	This variable calculates how much the representative female individual aged 13

Variable Type	Variable Name	Equation	Unit	Description
				differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013).
○	Distance Xfin to representative Up, Overweight, Female, Age 15	BMI Representative, Obese, Female, Age 15-Xfin, Overweight, Female, Age 15	kg/(meter*meter)	This variable calculates how much the representative female individual aged 15 differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013).
○	Distance Xfin to representative Up, Obese, Male, Age 11	Xfin, Obese, Male, Age 11-BMI Representative, Obese, Male, Age 11	kg/(meter*meter)	This variable calculates how much the representative male individual aged 11 differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013). In the case of Obese, there is no BMI group above it, therefore the final point of the range is the same as the Obese Xfin.
○	Distance Xfin to representative Up, Obese, Male, Age 13	Xfin, Obese, Male, Age 13-BMI Representative, Obese, Male, Age 13	kg/(meter*meter)	This variable calculates how much the representative male individual aged 13 differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013). In the case of Obese, there is no BMI group above it, therefore the final point of the range is the same as the Obese Xfin.
○	Distance Xfin to representative Up, Obese, Male, Age 15	Xfin, Obese, Male, Age 15-BMI Representative, Obese, Male, Age 15	kg/(meter*meter)	This variable calculates how much the representative male individual aged 15 differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013). In the case of Obese, there is no BMI group above it, therefore the final point of the range is the same as the Obese Xfin.
○	Distance Xfin to representative Up, Obese, Female, Age 11	Xfin, Obese, Female, Age 11-BMI Representative, Obese, Female, Age 11	kg/(meter*meter)	This variable calculates how much the representative female individual aged 11 differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013). In the case of Obese, there is no BMI group above it, therefore the final point of the range is the same as the Obese Xfin.
○	Distance Xfin to representative Up, Obese, Female, Age 13	Xfin, Obese, Female, Age 13-BMI Representative, Obese, Female, Age 13	kg/(meter*meter)	This variable calculates how much the representative female individual aged 13 differs from the final point of the range of the BMI group above to the one that the

Variable Type	Variable Name	Equation	Unit	Description
				representative individual belongs to (Fallah-fini et al., 2013). In the case of Obese, there is no BMI group above it, therefore the final point of the range is the same as the Obese Xfin.
○	Distance Xfin to representative Up, Obese, Female, Age 15	Xfin, Obese, Female, Age 15-BMI Representative, Obese, Female, Age 15	kg/(meter*meter)	This variable calculates how much the representative female individual aged 15 differs from the final point of the range of the BMI group above to the one that the representative individual belongs to (Fallah-fini et al., 2013). In the case of Obese, there is no BMI group above it, therefore the final point of the range is the same as the Obese Xfin.
○	Distance Xinit to representative Down, Normal Weight, Male, Age 11	BMI Representative, Normal Weight, Male, Age 11-Xinit, Normal Weight, Male, Age 11	kg/(meter*meter)	This variable calculates how much the representative male individual aged 11 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs to (Fallah-fini et al., 2013). In the case of Normal Weight, there is no BMI group below it, therefore the initial point of the range is the same as the Normal Weight Xinit.
○	Distance Xinit to representative Down, Normal Weight, Male, Age 13	BMI Representative, Normal Weight, Male, Age 13-Xinit, Normal Weight, Male, Age 13	kg/(meter*meter)	This variable calculates how much the representative male individual aged 13 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs to (Fallah-fini et al., 2013). In the case of Normal Weight, there is no BMI group below it, therefore the initial point of the range is the same as the Normal Weight Xinit.
○	Distance Xinit to representative Down, Normal Weight, Male, Age 15	BMI Representative, Normal Weight, Male, Age 15-Xinit, Normal Weight, Male, Age 15	kg/(meter*meter)	This variable calculates how much the representative male individual aged 15 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs to (Fallah-fini et al., 2013). In the case of Normal Weight, there is no BMI group below it, therefore the initial point of the range is the same as the Normal Weight Xinit.
○	Distance Xinit to representative Down, Normal Weight, Female, Age 11	BMI Representative, Normal Weight, Female, Age 11-Xinit, Normal Weight, Female, Age 11	kg/(meter*meter)	This variable calculates how much the representative female individual aged 11 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs to (Fallah-fini et al., 2013). In the case of

Variable Type	Variable Name	Equation	Unit	Description
				Normal Weight, there is no BMI group below it, therefore the initial point of the range is the same as the Normal Weight Xinit.
○	Distance Xinit to representative Down, Normal Weight, Female, Age 13	BMI Representative, Normal Weight, Female, Age 13-Xinit, Normal Weight, Female, Age 13	kg/(meter*meter)	This variable calculates how much the representative female individual aged 13 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs to (Fallah-fini et al., 2013). In the case of Normal Weight, there is no BMI group below it, therefore the initial point of the range is the same as the Normal Weight Xinit.
○	Distance Xinit to representative Down, Normal Weight, Female, Age 15	BMI Representative, Normal Weight, Female, Age 15-Xinit, Normal Weight, Female, Age 15	kg/(meter*meter)	This variable calculates how much the representative female individual aged 15 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs to (Fallah-fini et al., 2013). In the case of Normal Weight, there is no BMI group below it, therefore the initial point of the range is the same as the Normal Weight Xinit.
○	Distance Xinit to representative Down, Overweight, Male, Age 11	Xinit, Overweight, Male, Age 11-BMI Representative, Normal Weight, Male, Age 11	kg/(meter*meter)	This variable calculates how much the representative male individual aged 11 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs to (Fallah-fini et al., 2013).
○	Distance Xinit to representative Down, Overweight, Male, Age 13	Xinit, Overweight, Male, Age 13-BMI Representative, Normal Weight, Male, Age 13	kg/(meter*meter)	This variable calculates how much the representative male individual aged 13 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs to (Fallah-fini et al., 2013).
○	Distance Xinit to representative Down, Overweight, Male, Age 15	Xinit, Overweight, Male, Age 15-BMI Representative, Normal Weight, Male, Age 15	kg/(meter*meter)	This variable calculates how much the representative male individual aged 15 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs to (Fallah-fini et al., 2013).
○	Distance Xinit to representative Down, Overweight, Female, Age 11	Xinit, Overweight, Female, Age 11-BMI Representative, Normal Weight, Female, Age 11	kg/(meter*meter)	This variable calculates how much the representative female individual aged 11 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs to (Fallah-fini et al., 2013).
○	Distance Xinit to representative Down, Overweight, Female, Age 13	Xinit, Overweight, Female, Age 13-BMI Representative, Normal Weight, Female, Age 13	kg/(meter*meter)	This variable calculates how much the representative female individual aged 13

Variable Type	Variable Name	Equation	Unit	Description
				differs from the initial point of the range of the BMI group below to the one that the representative individual belongs to (Fallah-fini et al., 2013).
○	Distance Xinit to representative Down, Overweight, Female, Age 15	Xinit, Overweight, Female, Age 15-BMI Representative, Normal Weight, Female, Age 15	kg/(meter*meter)	This variable calculates how much the representative female individual aged 15 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs to (Fallah-fini et al., 2013).
○	Distance Xinit to representative Down, Obese, Male, Age 11	Xinit, Obese, Male, Age 11-BMI Representative, Overweight, Male, Age 11	kg/(meter*meter)	This variable calculates how much the representative male individual aged 11 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs to (Fallah-fini et al., 2013).
○	Distance Xinit to representative Down, Obese, Male, Age 13	Xinit, Obese, Male, Age 13-BMI Representative, Overweight, Male, Age 13	kg/(meter*meter)	This variable calculates how much the representative male individual aged 13 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs to (Fallah-fini et al., 2013).
○	Distance Xinit to representative Down, Obese, Male, Age 15	Xinit, Obese, Male, Age 15-BMI Representative, Overweight, Male, Age 15	kg/(meter*meter)	This variable calculates how much the representative male individual aged 15 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs to (Fallah-fini et al., 2013).
○	Distance Xinit to representative Down, Obese, Female, Age 11	Xinit, Obese, Female, Age 11-BMI Representative, Overweight, Female, Age 11	kg/(meter*meter)	This variable calculates how much the representative female individual aged 11 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs (Fallah-fini et al., 2013).
○	Distance Xinit to representative Down, Obese, Female, Age 13	Xinit, Obese, Female, Age 13-BMI Representative, Overweight, Female, Age 13	kg/(meter*meter)	This variable calculates how much the representative female individual aged 13 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs (Fallah-fini et al., 2013).
○	Distance Xinit to representative Down, Obese, Female, Age 15	Xinit, Obese, Female, Age 15-BMI Representative, Overweight, Female, Age 15	kg/(meter*meter)	This variable calculates how much the representative female individual aged 15 differs from the initial point of the range of the BMI group below to the one that the representative individual belongs (Fallah-fini et al., 2013).
○	Distance Xinit to representative Own, BMI Group, Gender, Age Group	BMI Representative-Xinit	kg/(meter*meter)	This variable calculates how much the representative individual differs from the initial point of the range to which the

Variable Type	Variable Name	Equation	Unit	Description
				representative individual belongs (Fallah-fini et al., 2013).
○	FFM INIT, BMI Group, Gender, Age Group	BW Representative-FM INIT	kg	This variable calculates the initial amount of FFM of the representative individual. It is calculated by subtracting the initial value of the FM from the BW of the representative individual.
○	FM Fraction Reference, BMI Group, Gender, Age Group	(BMI Coefficient for FM Fraction Reference*BMI Representative, BMI Group, Gender, Age Group-0.7*Year for Age, Age Group-3.6*1+1.4)/100	Dimensionless	This variable calculates the percentage of FM that is associated with each of the categories defined by each BMI group, gender, and age group (Cortes-Castell et al., 2017).
○	FM INIT, BMI Group, Gender, Age Group	BW Representative*FM Fraction Reference	kg	This variable calculates the initial amount of FM of the representative individual. It is obtained by the product of the BW of the representative individual and a reference FM fraction.
○	Height, Male, Age 11	1.47	Meters	This parameter indicates the adolescent's height according to their age and gender (Juliusson et al., 2007).
○	Height, Male, Age 13	1.59	Meters	This parameter indicates the adolescent's height according to their age and gender (Juliusson et al., 2007).
○	Height, Male, Age 15	1.73	Meters	This parameter indicates the adolescent's height according to their age and gender (Juliusson et al., 2007).
○	Height, Female, Age 11	1.47	Meters	This parameter indicates the adolescent's height according to their age and gender (Juliusson et al., 2007).
○	Height, Female, Age 13	1.58	Meters	This parameter indicates the adolescent's height according to their age and gender (Juliusson et al., 2007).
○	Height, Female, Age 15	1.66	Meters	This parameter indicates the adolescent's height according to their age and gender (Juliusson et al., 2007).
○	Indicated Change in BMI, BMI Group, Gender, Age Group	"Indicated BW dBW/dt"/(Height, Gender, Age Group*Height, Gender, Age Group)	kg/(year*meter*meter)	This variable represents the rate of change of BMI of the representative individual. The equation is a multiplication of the Indicated BW by the squared height. This variable is arrayed by gender and age group.
○	Leaving Down Rate, BMI Group, Gender, Age Group	MAX(-Indicated Change in BMI*Yk, 0)*Multiplier for Leaving Down Rate First Bin, BMI Group	People/Years	This variable calculates the number of adolescents moving from one BMI another. A negative rate of change of BMI of the representative individual for each BMI group implies that some of the population elements in that BMI group will move to the category below it (Fallah-fini et al., 2013).

Variable Type	Variable Name	Equation	Unit	Description
○	Leaving Up Rate, BMI Group, Gender, Age Group	MAX(Yk*Indicated Change in BMI, 0)*Multiplier for Leaving Up Rate Last Bin, BMI Group	People/Years	This variable calculates the number of adolescents moving from one BMI another. Positive values for the rate of change of BMI of the representative individual for each BMI group imply that some of the population elements in that BMI group will move to the category above it (Fallah-fini et al., 2013).
○	Multiplier for Leaving Down Rate First Bin, Normal Weight	0	Dimensionless	This is an operational parameter to activate the formulation Leaving Down Rate that calculates the number of individuals moving from one BMI group to another
○	Multiplier for Leaving Down Rate First Bin, Overweight	1	Dimensionless	This is an operational parameter to activate the formulation Leaving Down Rate that calculates the number of individuals moving from one BMI group to another
○	Multiplier for Leaving Down Rate First Bin, Obese	1	Dimensionless	This is an operational parameter to activate the formulation Leaving Down Rate that calculates the number of individuals moving from one BMI group to another
○	Multiplier for Leaving Up Rate Last Bin, Normal Weight	1	Dimensionless	This is an operational parameter to activate the formulation Leaving Up Rate that calculates the number of individuals moving from one BMI group to another
○	Multiplier for Leaving Up Rate Last Bin, Overweight	1	Dimensionless	This is an operational parameter to activate the formulation Leaving Up Rate that calculates the number of individuals moving from one BMI group to another
○	Multiplier for Leaving Up Rate Last Bin, Obese	0	Dimensionless	This is an operational parameter to activate the formulation Leaving Up Rate that calculates the number of individuals moving from one BMI group to another
○	Xfin, Normal Weight, Male, Age 11	20.55	kg/(meter*meter)	This parameter represents the end BMI value associated with the Normal Weight BMI group of male adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al. (2007).
○	Xfin, Normal Weight, Male, Age 13	21.91	kg/(meter*meter)	This parameter represents the end BMI value associated with the Normal Weight BMI group of male adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al. (2007).
○	Xfin, Normal Weight, Male, Age 15	23.29	kg/(meter*meter)	This parameter represents the end BMI value associated with the Normal Weight BMI group of male adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al. (2007).

Variable Type	Variable Name	Equation	Unit	Description
◯	Xfin, Normal Weight, Female, Age 11	20.74	kg/(meter*meter)	This parameter represents the end BMI value associated with the Normal Weight BMI group of female adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xfin, Normal Weight, Female, Age 13	22.58	kg/(meter*meter)	This parameter represents the end BMI value associated with the Normal Weight BMI group of female adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xfin, Normal Weight, Female, Age 15	23.94	kg/(meter*meter)	This parameter represents the end BMI value associated with the Normal Weight BMI group of female adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xfin, Overweight, Male, Age 11	25.10	kg/(meter*meter)	This parameter represents the end BMI value associated with the Overweight BMI group of male adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xfin, Overweight, Male, Age 13	26.84	kg/(meter*meter)	This parameter represents the end BMI value associated with the Overweight BMI group of male adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xfin, Overweight, Male, Age 15	28.30	kg/(meter*meter)	This parameter represents the end BMI value associated with the Overweight BMI group of male adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xfin, Overweight, Female, Age 11	25.42	kg/(meter*meter)	This parameter represents the end BMI value associated with the Overweight BMI group of female adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xfin, Overweight, Female, Age 13	27.76	kg/(meter*meter)	This parameter represents the end BMI value associated with the Overweight BMI group of female adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xfin, Overweight, Female, Age 15	29.11	kg/(meter*meter)	This parameter represents the end BMI value associated with the Overweight BMI group of female adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xfin, Obese, Male, Age 11	28.025	kg/(meter*meter)	This parameter represents the end BMI value associated with the Obese BMI group of male adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al. (2007).

Variable Type	Variable Name	Equation	Unit	Description
◯	Xfin, Obese, Male, Age 13	29.795	kg/(meter*meter)	This parameter represents the end BMI value associated with the Obese BMI group of male adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xfin, Obese, Male, Age 15	31.565	kg/(meter*meter)	This parameter represents the end BMI value associated with the Obese BMI group of male adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xfin, Obese, Female, Age 11	28.025	kg/(meter*meter)	This parameter represents the end BMI value associated with the Obese BMI group of female adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xfin, Obese, Female, Age 13	29.795	kg/(meter*meter)	This parameter represents the end BMI value associated with the Obese BMI group of female adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xfin, Obese, Female, Age 15	31.565	kg/(meter*meter)	This parameter represents the end BMI value associated with the Obese BMI group of female adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xinit, Normal Weight, Male, Age 11	14	kg/(meter*meter)	This parameter represents the start BMI value associated with the Normal Weight BMI group of male adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al. (2007)
◯	Xinit, Normal Weight, Male, Age 13	14	kg/(meter*meter)	This parameter represents the start BMI value associated with the Normal Weight BMI group of male adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al. (2007)
◯	Xinit, Normal Weight, Male, Age 15	14	kg/(meter*meter)	This parameter represents the start BMI value associated with the Normal Weight BMI group of male adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xinit, Normal Weight, Female, Age 11	14	kg/(meter*meter)	This parameter represents the start BMI value associated with the Normal Weight BMI group of female adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xinit, Normal Weight, Female, Age 13	14	kg/(meter*meter)	This parameter represents the start BMI value associated with the Normal Weight BMI group of female adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xinit, Normal Weight, Female, Age 15	14	kg/(meter*meter)	This parameter represents the start BMI value associated with the Normal Weight

Variable Type	Variable Name	Equation	Unit	Description
				BMI group of female adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al. (2007).
○	Xinit, Overweight, Male, Age 11	20.55	kg/(meter*meter)	This parameter represents the start BMI value associated with the Overweight BMI group of male adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al. (2007).
○	Xinit, Overweight, Male, Age 13	21.91	kg/(meter*meter)	This parameter represents the start BMI value associated with the Overweight BMI group of male adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al. (2007).
○	Xinit, Overweight, Male, Age 15	23.29	kg/(meter*meter)	This parameter represents the start BMI value associated with the Overweight BMI group of male adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al. (2007).
○	Xinit, Overweight, Female, Age 11	20.74	kg/(meter*meter)	This parameter represents the start BMI value associated with the Overweight BMI group of female adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al. (2007).
○	Xinit, Overweight, Female, Age 13	22.58	kg/(meter*meter)	This parameter represents the start BMI value associated with the Overweight BMI group of female adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al. (2007).
○	Xinit, Overweight, Female, Age 15	23.94	kg/(meter*meter)	This parameter represents the start BMI value associated with the Overweight BMI group of female adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al. (2007).
○	Xinit, Obese, Male, Age 11	25.10	kg/(meter*meter)	This parameter represents the start BMI value associated with the Obese BMI group of male adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al. (2007).
○	Xinit, Obese, Male, Age 13	26.84	kg/(meter*meter)	This parameter represents the start BMI value associated with the Obese BMI group of male adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al. (2007).
○	Xinit, Obese, Male, Age 15	28.30	kg/(meter*meter)	This parameter represents the start BMI value associated with the Obese BMI group of male adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al. (2007).
○	Xinit, Obese, Female, Age 11	25.42	kg/(meter*meter)	This parameter represents the start BMI value associated with the Obese BMI group of female adolescents aged 11 based on the BMI cut offs by Katzmarzyk et al. (2007).

Variable Type	Variable Name	Equation	Unit	Description
◯	Xinit, Obese, Female, Age 13	27.76	kg/(meter*meter)	This parameter represents the start BMI value associated with the Obese BMI group of female adolescents aged 13 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Xinit, Obese, Female, Age 15	29.11	kg/(meter*meter)	This parameter represents the start BMI value associated with the Obese BMI group of female adolescents aged 15 based on the BMI cut offs by Katzmarzyk et al. (2007).
◯	Year for Age, Age 11	11	Dimensionless	This parameter indicates the years of age that determines the FM fraction reference equation (Cortes-Castell et al., 2017).
◯	Year for Age, Age 13	13	Dimensionless	This parameter indicates the years of age that determines the FM fraction reference equation (Cortes-Castell et al., 2017).
◯	Year for Age, Age 15	15	Dimensionless	This parameter indicates the years of age that determines the FM fraction reference equation (Cortes-Castell et al., 2017).
◯	Yk, BMI Group, Gender, Age Group	Population segmented by BMI gender and age group/(Xfin, BMI Group, Gender, Age Group-Xinit, BMI Group, Gender, Age Group)	Meters^2*People /Kilograms	This equation calculates the BMI distribution for each subpopulation (Fallah-fini et al., 2013)
◯	Yk INIT, BMI Group, Gender, Age Group	INIT(Yk)	Meters^2*People /Kilograms	Initial value of the BMI distribution (Fallah-fini et al., 2013)
Energy Intake CO-FLOW				
	Additions to Total EI through Maturation Rate, Normal Weight, Male, Age 11	maturation A10 to A11, Normal Weight, Male*Base EI, Normal Weight, Male, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of male adolescents aged 10 to 11 and the base energy intake. This flow is arrayed by BMI group, gender and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Normal Weight, Male, Age 13	Reductions in Total EI through Maturation Rate, Normal Weight, Male, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by the rate of reductions in total energy intake of male adolescents aged 11. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Normal Weight, Male, Age 15	Reductions in Total EI through Maturation Rate, Normal Weight, Male, Age 13	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by the rate of reductions in total energy intake of

Variable Type	Variable Name	Equation	Unit	Description
				male adolescents aged 13. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Normal Weight, Female, Age 11	maturation A10 to A11, Normal Weight, Female*Base EI, Normal Weight, Female, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of female adolescents aged 10 to 11 and the base energy intake. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Normal Weight, Female, Age 13	Reductions in Total EI through Maturation Rate, Normal Weight, Female, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by the rate of reductions in total energy intake of female adolescents aged 11. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Normal Weight, Female, Age 15	Reductions in Total EI through Maturation Rate, Normal Weight, Female, Age 13	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by the rate of reductions in total energy intake of female adolescents aged 13. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Overweight, Male, Age 11	maturation A10 to A11, Overweight, Male*Base EI, Overweight, Male, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of male adolescents aged 10 to 11 and the base energy intake. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Overweight, Male, Age 13	Reductions in Total EI through Maturation Rate, Overweight, Male, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by the rate of reductions in total energy intake of male adolescents aged 11. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Overweight, Male, Age 15	Reductions in Total EI through Maturation Rate, Overweight, Male, Age 13	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by the rate of reductions in total energy intake of

Variable Type	Variable Name	Equation	Unit	Description
				male adolescents aged 13. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Overweight, Female, Age 11	maturation A10 to A11, Overweight, Female*Base EI, Overweight, Female, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of female adolescents aged 10 to 11 and the base energy intake. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Overweight, Female, Age 13	Reductions in Total EI through Maturation Rate, Overweight, Female, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by the rate of reductions in total energy intake of female adolescents aged 11. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Overweight, Female, Age 15	Reductions in Total EI through Maturation Rate, Overweight, Female, Age 13	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by the rate of reductions in total energy intake of female adolescents aged 13. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Obese, Male, Age 11	maturation A10 to A11, Obese, Male*Base EI, Obese, Male, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of male adolescents aged 10 to 11 and the base energy intake. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Obese, Male, Age 13	Reductions in Total EI through Maturation Rate, Obese, Male, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by the rate of reductions in total energy intake of male adolescents aged 11. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Obese, Male, Age 15	Reductions in Total EI through Maturation Rate, Obese, Male, Age 13	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by the rate of reductions in total energy intake of

Variable Type	Variable Name	Equation	Unit	Description
				male adolescents aged 13. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Obese, Female, Age 11	maturation A10 to A11, Obese, Female*Base EI, Obese, Female, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of female adolescents aged 10 to 11 and the base energy intake. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Obese, Female, Age 13	Reductions in Total EI through Maturation Rate, Obese, Female, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by the rate of reductions in total energy intake of female adolescents aged 11. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Additions to Total EI through Maturation Rate, Obese, Female, Age 15	Reductions in Total EI through Maturation Rate, Obese, Female, Age 13	Kilocalories*People/Years/Years	This flow represents the rate at which energy is added to the energy intake stock from maturation corresponding to the population groups. It is calculated by the rate of reductions in total energy intake of female adolescents aged 13. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Average Energy Intake, Normal Weight, Male, Age 11	Total Energy Intake, Normal Weight, Male, Age 11/Population Age 11, Normal Weight, Male	Kcal/years	This variable calculates the average energy supply associated with each population group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
	Average Energy Intake, Normal Weight, Male, Age 13	Total Energy Intake, Normal Weight, Male, Age 13/Population Age 13, Normal Weight, Male	Kcal/years	This variable calculates the average energy supply associated with each population group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
	Average Energy Intake, Normal Weight, Male, Age 15	Total Energy Intake, Normal Weight, Male, Age 15/Population Age 15, Normal Weight, Male	Kcal/years	This variable calculates the average energy supply associated with each population

Variable Type	Variable Name	Equation	Unit	Description
				group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
○	Average Energy Intake, Normal Weight, Female, Age 11	Total Energy Intake, Normal Weight, Female, Age 11/Population Age 11, Normal Weight, Female	Kcal/years	This variable calculates the average energy supply associated with each population group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
○	Average Energy Intake, Normal Weight, Female, Age 13	Total Energy Intake, Normal Weight, Female, Age 13/Population Age 13, Normal Weight, Female	Kcal/years	This variable calculates the average energy supply associated with each population group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
○	Average Energy Intake, Normal Weight, Female, Age 15	Total Energy Intake, Normal Weight, Female, Age 15/Population Age 15, Normal Weight, Female	Kcal/years	This variable calculates the average energy supply associated with each population group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
○	Average Energy Intake, Overweight, Male, Age 11	Total Energy Intake, Overweight, Male, Age 11/Population Age 11, Overweight, Male	Kcal/years	This variable calculates the average energy supply associated with each population group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
○	Average Energy Intake, Overweight, Male, Age 13	Total Energy Intake, Overweight, Male, Age 13/Population Age 13, Overweight, Male	Kcal/years	This variable calculates the average energy supply associated with each population

Variable Type	Variable Name	Equation	Unit	Description
				group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
○	Average Energy Intake, Overweight, Male, Age 15	Total Energy Intake, Overweight, Male, Age 15/Population Age 15, Overweight, Male	Kcal/years	This variable calculates the average energy supply associated with each population group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
○	Average Energy Intake, Overweight, Female, Age 11	Total Energy Intake, Overweight, Female, Age 11/Population Age 11, Overweight, Female	Kcal/years	This variable calculates the average energy supply associated with each population group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
○	Average Energy Intake, Overweight, Female, Age 13	Total Energy Intake, Overweight, Female, Age 13/Population Age 13, Overweight, Female	Kcal/years	This variable calculates the average energy supply associated with each population group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
○	Average Energy Intake, Overweight, Female, Age 15	Total Energy Intake, Overweight, Female, Age 15/Population Age 15, Overweight, Female	Kcal/years	This variable calculates the average energy supply associated with each population group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
○	Average Energy Intake, Obese, Male, Age 11	Total Energy Intake, Obese, Male, Age 11/Population Age 11, Obese, Male	Kcal/years	This variable calculates the average energy supply associated with each population

Variable Type	Variable Name	Equation	Unit	Description
				group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
◯	Average Energy Intake, Obese, Male, Age 13	Total Energy Intake, Obese, Male, Age 13/Population Age 13, Obese, Male	Kcal/years	This variable calculates the average energy supply associated with each population group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
◯	Average Energy Intake, Obese, Male, Age 15	Total Energy Intake, Obese, Male, Age 15/Population Age 15, Obese, Male	Kcal/years	This variable calculates the average energy supply associated with each population group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
◯	Average Energy Intake, Obese, Female, Age 11	Total Energy Intake, Obese, Female, Age 11/Population Age 11, Obese, Female	Kcal/years	This variable calculates the average energy supply associated with each population group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
◯	Average Energy Intake, Obese, Female, Age 13	Total Energy Intake, Obese, Female, Age 13/Population Age 13, Obese, Female	Kcal/years	This variable calculates the average energy supply associated with each population group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
◯	Average Energy Intake, Obese, Female, Age 15	Total Energy Intake, Obese, Female, Age 15/Population Age 15, Obese, Female	Kcal/years	This variable calculates the average energy supply associated with each population

Variable Type	Variable Name	Equation	Unit	Description
				group. It is determined by dividing the total energy stock of each group by the number of people in that group, we obtain the average energy supply for the representative individual for each group (Fallah-fini et al., 2013). This variable is arrayed by BMI group, gender, and age group.
○	EE Marginal Individual Xinit, BMI Group, Gender, Age Group	Energy Demand Representative Own*Weight Own in EE Marginal Individual Down+Energy Demand Representative Below*(1-Weight Own in EE Marginal Individual Down)	kcal/year	This variable calculates the resulting EE of a marginal individual. It is obtained by a weighted average between the Energy Demand of representative own and the Energy demand of the representative from the BMI group below. The weights are given by the Weight Own in EE Marginal Individual Down
○	EI Marginal Individual Down, BMI Group, Gender, Age Group	EE Marginal Individual Xinit*Energy Supply to Energy Demand Ratio Representative Individual	kcal/year	This variable calculates the Energy Supply (EI) of the marginal individual moving up from BMI group from below. It is obtained by multiplying the EE of the marginal individual Xinit and the ratio between energy supply and demand of the representative individual.
○	EI Marginal Individual Up, BMI Group, Gender, Age Group	EE Marginal Individual Xfin*Energy Supply to Energy Demand Ratio Representative Individual	kcal/year	This variable calculates the Energy Supply (EI) of the marginal individual moving down from BMI group from above. It is obtained by multiplying the EE of the marginal individual Xfin and the ratio between energy supply and demand of the representative individual.
○	EE Marginal Individual Xfin, BMI Group, Gender, Age Group	Energy Demand Representative Own*Weight Own in EE Marginal Individual Up+Energy Demand Representative Above*(1-Weight Own in EE Marginal Individual Up)	kcal/year	This variable calculates the resulting EE of a marginal individual. It is obtained by a weighted average between the Energy Demand of representative own and the Energy demand of the representative from the BMI group above. The weights are given by the Weight Own in EE Marginal Individual Up
○	Energy Demand Representative Above, Normal Weight, Male, Age 11	Energy Demand Representative Own, Overweight, Male, Age 11	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 11 from the BMI group above. In the case of Normal Weight, the EE corresponds to the one of Overweight.
○	Energy Demand Representative Above, Normal Weight, Male, Age 13	Energy Demand Representative Own, Overweight, Male, Age 13	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 13 from the BMI group above. In the case of Normal Weight, the EE corresponds to the one of Overweight.

Variable Type	Variable Name	Equation	Unit	Description
○	Energy Demand Representative Above, Normal Weight, Male, Age 15	Energy Demand Representative Own, Overweight, Male, Age 15	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 15 from the BMI group above. In the case of Normal Weight, the EE corresponds to the one of Overweight.
○	Energy Demand Representative Above, Normal Weight, Female, Age 11	Energy Demand Representative Own, Overweight, Female, Age 11	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 11 from the BMI group above. In the case of Normal Weight, the EE corresponds to the one of Overweight.
○	Energy Demand Representative Above, Normal Weight, Female, Age 13	Energy Demand Representative Own, Overweight, Female, Age 13	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 13 from the BMI group above. In the case of Normal Weight, the EE corresponds to the one of Overweight.
○	Energy Demand Representative Above, Normal Weight, Female, Age 15	Energy Demand Representative Own, Overweight, Female, Age 15	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 15 from the BMI group above. In the case of Normal Weight, the EE corresponds to the one of Overweight.
○	Energy Demand Representative Above, Overweight, Male, Age 11	Energy Demand Representative Own, Obese, Male, Age 11	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 11 from the BMI group above. In the case of Overweight, the EE corresponds to the one of Obese.
○	Energy Demand Representative Above, Overweight, Male, Age 13	Energy Demand Representative Own, Obese, Male, Age 13	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 13 from the BMI group above. In the case of Overweight, the EE corresponds to the one of Obese.
○	Energy Demand Representative Above, Overweight, Male, Age 15	Energy Demand Representative Own, Obese, Male, Age 15	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 15 from the BMI group above. In the case of Overweight, the EE corresponds to the one of Obese.
○	Energy Demand Representative Above, Overweight, Female, Age 11	Energy Demand Representative Own, Obese, Female, Age 11	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 11 from the BMI group above. In the case of Overweight, the EE corresponds to the one of Obese.
○	Energy Demand Representative Above, Overweight, Female, Age 13	Energy Demand Representative Own, Obese, Female, Age 13	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 13 from the BMI group above. In the case of Overweight, the EE corresponds to the one of Obese.
○	Energy Demand Representative Above, Overweight, Female, Age 15	Energy Demand Representative Own, Obese, Female, Age 15	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 15 from the BMI group above. In the case of Overweight, the EE corresponds to the one of Obese.

Variable Type	Variable Name	Equation	Unit	Description
○	Energy Demand Representative Above, Obese, Male, Age 11	Energy Demand Representative Own, Obese, Male, Age 11	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 11 from the BMI group above. In the case of Obese, the EE corresponds to its own since there is no BMI group above Obese.
○	Energy Demand Representative Above, Obese, Male, Age 13	Energy Demand Representative Own, Obese, Male, Age 13	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 13 from the BMI group above. In the case of Obese, the EE corresponds to its own since there is no BMI group above Obese.
○	Energy Demand Representative Above, Obese, Male, Age 15	Energy Demand Representative Own, Obese, Male, Age 15	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 15 from the BMI group above. In the case of Obese, the EE corresponds to its own since there is no BMI group above Obese.
○	Energy Demand Representative Above, Obese, Female, Age 11	Energy Demand Representative Own, Obese, Female, Age 11	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 11 from the BMI group above. In the case of Obese, the EE corresponds to its own since there is no BMI group above Obese.
○	Energy Demand Representative Above, Obese, Female, Age 13	Energy Demand Representative Own, Obese, Female, Age 13	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 13 from the BMI group above. In the case of Obese, the EE corresponds to its own since there is no BMI group above Obese.
○	Energy Demand Representative Above, Obese, Female, Age 15	Energy Demand Representative Own, Obese, Female, Age 15	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 15 from the BMI group above. In the case of Obese, the EE corresponds to its own since there is no BMI group above Obese.
○	Energy Demand Representative Below, Normal Weight, Male, Age 11	Energy Demand Representative Own, Normal Weight, Male, Age 11	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 11 from the BMI group below. In the case of Normal Weight, the EE corresponds to its own since there is no BMI group below Normal weight.
○	Energy Demand Representative Below, Normal Weight, Male, Age 13	Energy Demand Representative Own, Normal Weight, Male, Age 13	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 13 from the BMI group below. In the case of Normal Weight, the EE corresponds to its own since there is no BMI group below Normal weight.
○	Energy Demand Representative Below, Normal Weight, Male, Age 15	Energy Demand Representative Own, Normal Weight, Male, Age 15	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 15 from the BMI group below. In the case of Normal Weight, the EE corresponds to

Variable Type	Variable Name	Equation	Unit	Description
				its own since there is no BMI group below Normal weight.
	Energy Demand Representative Below, Normal Weight, Female, Age 11	Energy Demand Representative Own, Normal Weight, Female, Age 11	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 11 from the BMI group below. In the case of Normal Weight, the EE corresponds to its own since there is no BMI group below Normal weight.
	Energy Demand Representative Below, Normal Weight, Female, Age 13	Energy Demand Representative Own, Normal Weight, Female, Age 13	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 13 from the BMI group below. In the case of Normal Weight, the EE corresponds to its own since there is no BMI group below Normal weight.
	Energy Demand Representative Below, Normal Weight, Female, Age 15	Energy Demand Representative Own, Normal Weight, Female, Age 15	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 15 from the BMI group below. In the case of Normal Weight, the EE corresponds to its own since there is no BMI group below Normal weight.
	Energy Demand Representative Below, Overweight, Male, Age 11	Energy Demand Representative Own, Normal Weight, Male, Age 11	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 11 from the BMI group below. In the case of Overweight the EE corresponds to the one of Normal Weight.
	Energy Demand Representative Below, Overweight, Male, Age 13	Energy Demand Representative Own, Normal Weight, Male, Age 13	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 13 from the BMI group below. In the case of Overweight the EE corresponds to the one of Normal Weight.
	Energy Demand Representative Below, Overweight, Male, Age 15	Energy Demand Representative Own, Normal Weight, Male, Age 15	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 15 from the BMI group below. In the case of Overweight the EE corresponds to the one of Normal Weight.
	Energy Demand Representative Below, Overweight, Female, Age 11	Energy Demand Representative Own, Normal Weight, Female, Age 11	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 11 from the BMI group below. In the case of Overweight the EE corresponds to the one of Normal Weight.
	Energy Demand Representative Below, Overweight, Female, Age 13	Energy Demand Representative Own, Normal Weight, Female, Age 13	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 13 from the BMI group below. In the case of Overweight the EE corresponds to the one of Normal Weight.
	Energy Demand Representative Below, Overweight, Female, Age 15	Energy Demand Representative Own, Normal Weight, Female, Age 15	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 15 from the BMI group below. In the case of Overweight the EE corresponds to the one of Normal Weight.

Variable Type	Variable Name	Equation	Unit	Description
	Energy Demand Representative Below, Obese, Male, Age 11	Energy Demand Representative Own, Overweight, Male, Age 11	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 11 from the BMI group below. In the case of Obese the EE corresponds to the one of Overweight.
	Energy Demand Representative Below, Obese, Male, Age 13	Energy Demand Representative Own, Overweight, Male, Age 13	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 13 from the BMI group below. In the case of Obese the EE corresponds to the one of Overweight.
	Energy Demand Representative Below, Obese, Male, Age 15	Energy Demand Representative Own, Overweight, Male, Age 15	kcal/year	This variable calculates the energy demand (EE) of representative male individual aged 15 from the BMI group below. In the case of Obese the EE corresponds to the one of Overweight.
	Energy Demand Representative Below, Obese, Female, Age 11	Energy Demand Representative Own, Overweight, Female, Age 11	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 11 from the BMI group below. In the case of Obese the EE corresponds to the one of Overweight.
	Energy Demand Representative Below, Obese, Female, Age 13	Energy Demand Representative Own, Overweight, Female, Age 13	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 13 from the BMI group below. In the case of Obese the EE corresponds to the one of Overweight.
	Energy Demand Representative Below, Obese, Female, Age 15	Energy Demand Representative Own, Overweight, Female, Age 15	kcal/year	This variable calculates the energy demand (EE) of representative female individual aged 15 from the BMI group below. In the case of Obese the EE corresponds to the one of Overweight.
	Energy Demand Representative Own, BMI Group, Gender, Age Group	Base EI	kcal/year	This variable calculates the energy demand (EE) of representative individual from the current BMI group which is equal to the base energy intake. It is arrayed by BMI group, gender and age group.
	Energy Supply to Energy Demand Ratio Representative Individual, BMI Group, Gender, Age Group	Average Energy Intake/Energy Demand Representative Own	Dimensionless	This variable calculates the ratio comparing the indicated energy intake (supply) and the energy expenditure (demand) of the representative individual. It is arrayed by BMI group, gender, and age group.
	Increase in Total EI from Inflow from Above, Normal Weight, Male, Age 11	Reduction in Total EI from Outflow Down, Overweight, Male, Age 11	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 11. When an individual leaves the Overweight BMI group to Normal Weight, this rate also adds his energy intake which is reflected in the total energy of that BMI group.

Variable Type	Variable Name	Equation	Unit	Description
	Increase in Total EI from Inflow from Above, Normal Weight, Male, Age 13	Reduction in Total EI from Outflow Down, Overweight, Male, Age 11	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 13. When an individual leaves the Overweight BMI group to Normal Weight, this rate also adds his energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Above, Normal Weight, Male, Age 15	Reduction in Total EI from Outflow Down, Overweight, Male, Age 15	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 15. When an individual leaves the Overweight BMI group to Normal Weight, this rate also adds his energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Above, Normal Weight, Female, Age 11	Reduction in Total EI from Outflow Down, Overweight, Female, Age 11	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 11. When an individual leaves the Overweight BMI group to Normal Weight, this rate also adds her energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Above, Normal Weight, Female, Age 13	Reduction in Total EI from Outflow Down, Overweight, Female, Age 13	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 13. When an individual leaves the Overweight BMI group to Normal Weight, this rate also adds her energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Above, Normal Weight, Female, Age 15	Reduction in Total EI from Outflow Down, Overweight, Female, Age 15	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 11. When an individual leaves the Overweight BMI group to Normal Weight, this rate also adds her energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Above, Overweight, Male, Age 11	Reduction in Total EI from Outflow Down, Obese, Male, Age 11	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 11. When an individual leaves the Obese BMI group to Overweight, this rate also adds his energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Above, Overweight, Male, Age 13	Reduction in Total EI from Outflow Down, Obese, Male, Age 13	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 13. When an individual leaves the Obese BMI group to Overweight, this rate also adds his energy intake which is reflected in the total energy of that BMI group.

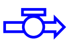
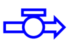
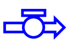
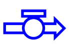
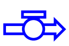
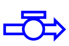
Variable Type	Variable Name	Equation	Unit	Description
	Increase in Total EI from Inflow from Above, Overweight, Male, Age 15	Reduction in Total EI from Outflow Down, Obese, Male, Age 15	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 15. When an individual leaves the Obese BMI group to Overweight, this rate also adds his energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Above, Overweight, Female, Age 11	Reduction in Total EI from Outflow Down, Obese, Female, Age 11	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 11. When an individual leaves the Obese BMI group to Overweight, this rate also adds her energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Above, Overweight, Female, Age 13	Reduction in Total EI from Outflow Down, Obese, Female, Age 13	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 13. When an individual leaves the Obese BMI group to Overweight, this rate also adds her energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Above, Overweight, Female, Age 15	Reduction in Total EI from Outflow Down, Obese, Female, Age 15	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 15. When an individual leaves the Obese BMI group to Overweight, this rate also adds her energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Above, Obese, Male, Age 11	0	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 11. Since there is no BMI group above Obese, the value of this flow is always 0.
	Increase in Total EI from Inflow from Above, Obese, Male, Age 13	0	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 13. Since there is no BMI group above Obese, the value of this flow is always 0.
	Increase in Total EI from Inflow from Above, Obese, Male, Age 15	0	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 15. Since there is no BMI group above Obese, the value of this flow is always 0.
	Increase in Total EI from Inflow from Above, Obese, Female, Age 11	0	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 11. Since there is no BMI group above Obese, the value of this flow is always 0.

Variable Type	Variable Name	Equation	Unit	Description
	Increase in Total EI from Inflow from Above, Obese, Female, Age 13	0	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 13. Since there is no BMI group above Obese, the value of this flow is always 0.
	Increase in Total EI from Inflow from Above, Obese, Female, Age 15	0	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 15. Since there is no BMI group above Obese, the value of this flow is always 0.
	Increase in Total EI from Inflow from Below, Normal Weight, Male, Age 11	0	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 11. Since there is no BMI group below Normal Weight, the value of this flow is always 0.
	Increase in Total EI from Inflow from Below, Normal Weight, Male, Age 13	0	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 13. Since there is no BMI group below Normal Weight, the value of this flow is always 0.
	Increase in Total EI from Inflow from Below, Normal Weight, Male, Age 15	0	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 15. Since there is no BMI group below Normal Weight, the value of this flow is always 0.
	Increase in Total EI from Inflow from Below, Normal Weight, Female, Age 11	0	Kilocalories*People/Years/Years	This flow calculates how much energy is added from the energy intake co-flow to of female adolescents aged 11. Since there is no BMI group below Normal Weight, the value of this flow is always 0.
	Increase in Total EI from Inflow from Below, Normal Weight, Female, Age 13	0	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 13. Since there is no BMI group below Normal Weight, the value of this flow is always 0.
	Increase in Total EI from Inflow from Below, Normal Weight, Female, Age 15	0	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 15. Since there is no BMI group below Normal Weight, the value of this flow is always 0.
	Increase in Total EI from Inflow from Below, Overweight, Male, Age 11	Reduction in Total EI from Outflow Up, Normal Weight, Male, Age 11	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 11. When an individual leaves the Normal Weight BMI group to Overweight, this rate also adds his energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Below, Overweight, Male, Age 13	Reduction in Total EI from Outflow Up, Normal Weight, Male, Age 13	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 13. When an

Variable Type	Variable Name	Equation	Unit	Description
				individual leaves the Normal Weight BMI group to Overweight, this rate also adds his energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Below, Overweight, Male, Age 15	Reduction in Total EI from Outflow Up, Normal Weight, Male, Age 15	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 15. When an individual leaves the Normal Weight BMI group to Overweight, this rate also adds his energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Below, Overweight, Female, Age 11	Reduction in Total EI from Outflow Up, Normal Weight, Female, Age 11	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 11. When an individual leaves the Normal Weight BMI group to Overweight, this rate also adds her energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Below, Overweight, Female, Age 13	Reduction in Total EI from Outflow Up, Normal Weight, Female, Age 13	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 13. When an individual leaves the Normal Weight BMI group to Overweight, this rate also adds her energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Below, Overweight, Female, Age 15	Reduction in Total EI from Outflow Up, Normal Weight, Female, Age 15	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 15. When an individual leaves the Normal Weight BMI group to Overweight, this rate also adds her energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Below, Obese, Male, Age 11	Reduction in Total EI from Outflow Up, Overweight, Male, Age 11	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 11. When an individual leaves the Overweight BMI group to Obese, this rate also adds his energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Below, Obese, Male, Age 13	Reduction in Total EI from Outflow Up, Overweight, Male, Age 13	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 13. When an individual leaves the Overweight BMI group to Obese, this rate also adds his energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Below, Obese, Male, Age 15	Reduction in Total EI from Outflow Up, Overweight, Male, Age 15	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of male adolescents aged 15. When an individual leaves the Overweight BMI group

Variable Type	Variable Name	Equation	Unit	Description
				group to Obese, this rate also adds his energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Below, Obese, Female, Age 11	Reduction in Total EI from Outflow Up, Overweight, Female, Age 11	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 11. When an individual leaves the Overweight BMI group to Obese, this rate also adds her energy intake which is reflected in the total energy of that BMI group.
	Increase in Total EI from Inflow from Below, Obese, Female, Age 13	Reduction in Total EI from Outflow Up, Overweight, Female, Age 13	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 13. When an individual leaves the Overweight BMI group to Obese, this rate also adds her energy intake which is reflected in the total energy of that BMI group
	Increase in Total EI from Inflow from Below, Obese, Female, Age 15	Reduction in Total EI from Outflow Up, Overweight, Female, Age 15	Kilocalories*People/Years/Years	This flow calculates how much energy is added to the energy intake co-flow stock of female adolescents aged 15. When an individual leaves the Overweight BMI group to Obese, this rate also adds her energy intake which is reflected in the total energy of that BMI group
	Reduction in Total EI from Outflow Down, Normal Weight, Male, Age 11	EI Marginal Individual Down, Normal Weight, Male, Age 11*Outflow from BMI Bin Down A11, Normal Weight, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 11. Since there is no BMI group below Normal Weight, the value of this flow is always 0.
	Reduction in Total EI from Outflow Down, Normal Weight, Male, Age 13	EI Marginal Individual Down, Normal Weight, Male, Age 13*Outflow from BMI Bin Down A13, Normal Weight, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 13. Since there is no BMI group below Normal Weight, the value of this flow is always 0.
	Reduction in Total EI from Outflow Down, Normal Weight, Male, Age 15	EI Marginal Individual Down, Normal Weight, Male, Age 15*Outflow from BMI Bin Down A15, Normal Weight, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 15. Since there is no BMI group below Normal Weight, the value of this flow is always 0.
	Reduction in Total EI from Outflow Down, Normal Weight, Female, Age 11	EI Marginal Individual Down, Normal Weight, Female, Age 11*Outflow from BMI Bin Down A11, Normal Weight, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 11. Since there is no BMI group below Normal Weight, the value of this flow is always 0.
	Reduction in Total EI from Outflow Down, Normal Weight, Female, Age 13	EI Marginal Individual Down, Normal Weight, Female, Age 13*Outflow from BMI Bin Down A13, Normal Weight, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 13. Since there is no BMI group below Normal Weight, the value of this flow is always 0.

Variable Type	Variable Name	Equation	Unit	Description
	Reduction in Total EI from Outflow Down, Normal Weight, Female, Age 15	EI Marginal Individual Down, Normal Weight, Female, Age 15*Outflow from BMI Bin Down A15, Normal Weight, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 15. Since there is no BMI group below Normal Weight, the value of this flow is always 0.
	Reduction in Total EI from Outflow Down, Overweight, Male, Age 11	EI Marginal Individual Down, Overweight, Male, Age 11*Outflow from BMI Bin Down A11, Overweight, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 11. When an individual leaves the Overweight BMI group to Normal Weight, this rate also removes his energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Down, Overweight, Male, Age 13	EI Marginal Individual Down, Overweight, Male, Age 13*Outflow from BMI Bin Down A13, Overweight, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 13. When an individual leaves the Overweight BMI group to Normal Weight, this rate also removes his energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Down, Overweight, Male, Age 15	EI Marginal Individual Down, Overweight, Male, Age 15*Outflow from BMI Bin Down A15, Overweight, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 15. When an individual leaves the Overweight BMI group to Normal Weight, this rate also removes his energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Down, Overweight, Female, Age 11	EI Marginal Individual Down, Overweight, Female, Age 11*Outflow from BMI Bin Down A11, Overweight, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 11. When an individual leaves the Overweight BMI group to Normal Weight, this rate also removes her energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Down, Overweight, Female, Age 13	EI Marginal Individual Down, Overweight, Female, Age 13*Outflow from BMI Bin Down A13, Overweight, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 13. When an individual leaves the Overweight BMI group to Normal Weight, this rate also removes her energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Down, Overweight, Female, Age 15	EI Marginal Individual Down, Overweight, Female, Age 15*Outflow from BMI Bin Down A15, Overweight, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 15. When an individual leaves the Overweight BMI group to Normal Weight, this rate also

Variable Type	Variable Name	Equation	Unit	Description
				removes her energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Down, Obese, Male, Age 11	EI Marginal Individual Down, Obese, Male, Age 11*Outflow from BMI Bin Down A11, Obese, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 11. When an individual leaves the Obese BMI group to Overweight, this rate also removes his energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Down, Obese, Male, Age 13	EI Marginal Individual Down, Obese, Male, Age 13*Outflow from BMI Bin Down A13, Obese, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 13. When an individual leaves the Obese BMI group to Overweight, this rate also removes his energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Down, Obese, Male, Age 15	EI Marginal Individual Down, Obese, Male, Age 15*Outflow from BMI Bin Down A15, Obese, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 15. When an individual leaves the Obese BMI group to Overweight, this rate also removes his energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Down, Obese, Female, Age 11	EI Marginal Individual Down, Obese, Female, Age 11*Outflow from BMI Bin Down A11, Obese, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 11. When an individual leaves the Obese BMI group to Overweight, this rate also removes her energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Down, Obese, Female, Age 13	EI Marginal Individual Down, Obese, Female, Age 13*Outflow from BMI Bin Down A13, Obese, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 13. When an individual leaves the Obese BMI group to Overweight, this rate also removes her energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Down, Obese, Female, Age 15	EI Marginal Individual Down, Obese, Female, Age 15*Outflow from BMI Bin Down A15, Obese, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 15. When an individual leaves the Obese BMI group to Overweight, this rate also removes her energy intake which is reflected in the total energy of that category.

Variable Type	Variable Name	Equation	Unit	Description
	Reduction in Total EI from Outflow Up, Normal Weight, Male, Age 11	EI Marginal Individual Xfin, Normal Weight, Male, Age 11*Outflow from BMI Bin Up A11, Normal Weight, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 11. When an individual leaves the Normal Weight BMI group to Overweight, this rate also removes his energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Up, Normal Weight, Male, Age 13	EI Marginal Individual Xfin, Normal Weight, Male, Age 13*Outflow from BMI Bin Up A13, Normal Weight, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 13. When an individual leaves the Normal Weight BMI group to Overweight, this rate also removes his energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Up, Normal Weight, Male, Age 15	EI Marginal Individual Xfin, Normal Weight, Male, Age 15*Outflow from BMI Bin Up A15, Normal Weight, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 15. When an individual leaves the Normal Weight BMI group to Overweight, this rate also removes his energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Up, Normal Weight, Female, Age 11	EI Marginal Individual Xfin, Normal Weight, Female, Age 11*Outflow from BMI Bin Up A11, Normal Weight, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 11. When an individual leaves the Normal Weight BMI group to Overweight, this rate also removes her energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Up, Normal Weight, Female, Age 13	EI Marginal Individual Xfin, Normal Weight, Female, Age 13*Outflow from BMI Bin Up A13, Normal Weight, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 13. When an individual leaves the Normal Weight BMI group to Overweight, this rate also removes her energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Up, Normal Weight, Female, Age 15	EI Marginal Individual Xfin, Normal Weight, Female, Age 15*Outflow from BMI Bin Up A15, Normal Weight, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 15. When an individual leaves the Normal Weight BMI group to Overweight, this rate also removes her energy intake which is reflected in the total energy of that category.

Variable Type	Variable Name	Equation	Unit	Description
	Reduction in Total EI from Outflow Up, Overweight, Male, Age 11	EI Marginal Individual Xfin, Overweight, Male, Age 11*Outflow from BMI Bin Up A11, Overweight, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 11. When an individual leaves the Overweight BMI group to Obese, this rate also removes his energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Up, Overweight, Male, Age 13	EI Marginal Individual Xfin, Overweight, Male, Age 13*Outflow from BMI Bin Up A13, Overweight, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 13. When an individual leaves the Overweight BMI group to Obese, this rate also removes his energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Up, Overweight, Male, Age 15	EI Marginal Individual Xfin, Overweight, Male, Age 15*Outflow from BMI Bin Up A15, Overweight, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 15. When an individual leaves the Overweight BMI group to Obese, this rate also removes his energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Up, Overweight, Female, Age 11	EI Marginal Individual Xfin, Overweight, Female, Age 11*Outflow from BMI Bin Up A11, Overweight, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 11. When an individual leaves the Overweight BMI group to Obese, this rate also removes her energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Up, Overweight, Female, Age 13	EI Marginal Individual Xfin, Overweight, Female, Age 13*Outflow from BMI Bin Up A13, Overweight, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 13. When an individual leaves the Overweight BMI group to Obese, this rate also removes her energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Up, Overweight, Female, Age 15	EI Marginal Individual Xfin, Overweight, Female, Age 15*Outflow from BMI Bin Up A15, Overweight, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 15. When an individual leaves the Overweight BMI group to Obese, this rate also removes her energy intake which is reflected in the total energy of that category.
	Reduction in Total EI from Outflow Up, Obese, Male, Age 11	EI Marginal Individual Xfin, Obese, Male, Age 11*Outflow from BMI Bin Up A11, Obese, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 11. Since there is no BMI group above Obese, the value of this flow is always 0.
	Reduction in Total EI from Outflow Up, Obese, Male, Age 13	EI Marginal Individual Xfin, Obese, Male, Age 13*Outflow from BMI Bin Up A13, Obese, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 13. Since

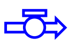
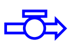
Variable Type	Variable Name	Equation	Unit	Description
				there is no BMI group above Obese, the value of this flow is always 0.
	Reduction in Total EI from Outflow Up, Obese, Male, Age 15	EI Marginal Individual Xfin, Obese, Male, Age 15*Outflow from BMI Bin Up A15, Obese, Male	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of male adolescents aged 15. Since there is no BMI group above Obese, the value of this flow is always 0.
	Reduction in Total EI from Outflow Up, Obese, Female, Age 11	EI Marginal Individual Xfin, Obese, Female, Age 11*Outflow from BMI Bin Up A11, Obese, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 11. Since there is no BMI group above Obese, the value of this flow is always 0.
	Reduction in Total EI from Outflow Up, Obese, Female, Age 13	EI Marginal Individual Xfin, Obese, Female, Age 13*Outflow from BMI Bin Up A13, Obese, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 13. Since there is no BMI group above Obese, the value of this flow is always 0.
	Reduction in Total EI from Outflow Up, Obese, Female, Age 15	EI Marginal Individual Xfin, Obese, Female, Age 15*Outflow from BMI Bin Up A15, Obese, Female	Kilocalories*People/Years/Years	This flow calculates how much energy is removed from the energy intake co-flow stock of female adolescents aged 15. Since there is no BMI group above Obese, the value of this flow is always 0.
	Reductions in Total EI through Maturation Rate, Normal Weight, Male, Age 11	maturation A11 to A13, Normal Weight, Male*Average Energy Intake, Normal Weight, Male, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of male adolescents aged 11 to 13 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013).
	Reductions in Total EI through Maturation Rate, Normal Weight, Male, Age 13	maturation A13 to A15, Normal Weight, Male*Average Energy Intake, Normal Weight, Male, Age 13	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of male adolescents aged 13 to 15 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013).
	Reductions in Total EI through Maturation Rate, Normal Weight, Male, Age 15	maturation A15 to A17, Normal Weight, Male*Average Energy Intake, Normal Weight, Male, Age 15	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of male adolescents aged 15 to 17 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group,

Variable Type	Variable Name	Equation	Unit	Description
				gender, and age group (Fallah-fini et al., 2013).
	Reductions in Total EI through Maturation Rate, Normal Weight, Female, Age 11	maturation A11 to A13, Normal Weight, Female*Average Energy Intake, Normal Weight, Female, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of female adolescents aged 11 to 13 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013).
	Reductions in Total EI through Maturation Rate, Normal Weight, Female, Age 13	maturation A13 to A15, Normal Weight, Female*Average Energy Intake, Normal Weight, Female, Age 13	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of female adolescents aged 13 to 15 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013).
	Reductions in Total EI through Maturation Rate, Normal Weight, Female, Age 15	maturation A15 to A17, Normal Weight, Female*Average Energy Intake, Normal Weight, Female, Age 15	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of female adolescents aged 15 to 17 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013).
	Reductions in Total EI through Maturation Rate, Overweight, Male, Age 11	maturation A11 to A13, Overweight, Male*Average Energy Intake, Overweight, Male, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of male adolescents aged 11 to 13 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013).
	Reductions in Total EI through Maturation Rate, Overweight, Male, Age 13	maturation A13 to A15, Overweight, Male*Average Energy Intake, Overweight, Male, Age 13	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of male adolescents aged 13 to 15 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group,

Variable Type	Variable Name	Equation	Unit	Description
				gender, and age group (Fallah-fini et al., 2013).
	Reductions in Total EI through Maturation Rate, Overweight, Male, Age 15	maturation A15 to A17, Overweight, Male*Average Energy Intake, Overweight, Male, Age 15	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of male adolescents aged 15 to 17 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013).
	Reductions in Total EI through Maturation Rate, Overweight, Female, Age 11	maturation A11 to A13, Overweight, Female*Average Energy Intake, Overweight, Female, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of female adolescents aged 11 to 13 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013).
	Reductions in Total EI through Maturation Rate, Overweight, Female, Age 13	maturation A13 to A15, Overweight, Female*Average Energy Intake, Overweight, Female, Age 13	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of female adolescents aged 13 to 15 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Reductions in Total EI through Maturation Rate, Overweight, Female, Age 15	maturation A15 to A17, Overweight, Female*Average Energy Intake, Overweight, Female, Age 15	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of female adolescents aged 15 to 17 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Reductions in Total EI through Maturation Rate, Obese, Male, Age 11	maturation A11 to A13, Obese, Male*Average Energy Intake, Obese, Male, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of male adolescents aged 11 to 13 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group,

Variable Type	Variable Name	Equation	Unit	Description
				gender, and age group (Fallah-fini et al., 2013)
	Reductions in Total EI through Maturation Rate, Obese, Male, Age 13	maturation A13 to A15, Obese, Male*Average Energy Intake, Obese, Male, Age 13	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of male adolescents aged 13 to 15 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Reductions in Total EI through Maturation Rate, Obese, Male, Age 15	maturation A15 to A17, Obese, Male*Average Energy Intake, Obese, Male, Age 15	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of male adolescents aged 15 to 17 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Reductions in Total EI through Maturation Rate, Obese, Female, Age 11	maturation A11 to A13, Obese, Female*Average Energy Intake, Obese, Female, Age 11	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of female adolescents aged 11 to 13 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Reductions in Total EI through Maturation Rate, Obese, Female, Age 13	maturation A13 to A15, Obese, Female*Average Energy Intake, Obese, Female, Age 13	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of female adolescents aged 13 to 15 and the average energy intake for the corresponding BMI group. This flow is arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Reductions in Total EI through Maturation Rate, Obese, Female, Age 15	maturation A15 to A17, Obese, Female*Average Energy Intake, Obese, Female, Age 15	Kilocalories*People/Years/Years	This flow represents the rate at which energy is removed from the energy intake stock from maturation corresponding to the population groups. It is calculated by multiplying the rate of maturation of female adolescents aged 15 to 17 and the average energy intake for the corresponding BMI group. This flow is

Variable Type	Variable Name	Equation	Unit	Description
				arrayed by BMI group, gender, and age group (Fallah-fini et al., 2013)
	Total Energy Intake, BMI Group, Gender, Age Group(t)	Total Energy Intake, BMI Group, Gender, Age Group(t - dt) + (Additions to Total EI through Maturation Rate, BMI Group, Gender, Age Group + Increase in Total EI from Inflow from Below, BMI Group, Gender, Age Group + Increase in Total EI from Inflow from Above, BMI Group, Gender, Age Group - Reductions in Total EI through Maturation Rate, BMI Group, Gender, Age Group - Reduction in Total EI from Outflow Down, BMI Group, Gender, Age Group - Reduction in Total EI from Outflow Up, BMI Group, Gender, Age Group) * dt	Kilocalories*People/Years	This is a stock variable that calculates the total energy supply (intake) at each point in time. It is accumulated by integrated difference between the inflow additions to total EI through maturation, the inflow Increase in total EI from inflow from below, the inflow Increase in Total EI from inflow from above and the outflows reductions in Total EI through maturation, outflow reduction in Total EI from outflow down, outflow reductions in total EI from outflow up. This stock is arrayed by BMI group, gender, and age group. The initial value of the stock is base consumption multiplied by the initial value of the population groups.
	Weight Own in EE Marginal Individual Down, BMI Group, Gender, Age Group	Distance Xinit to representative Down/ (Distance Xinit to representative Down+Distance Xinit to representative Own)	Dimensionless	This variable determines the energy demand associated with the marginal individual. The weights are based on the relative distance of the marginal individual with respect to the representative individual from the BMI group below it, and the representative individual from its own BMI group (Fallah-fini et al., 2013)
	Weight Own in EE Marginal Individual Up, BMI Group, Gender, Age Group	Distance Xfin to representative Up/ (Distance Xfin to representative Up+Distance Xfin to representative Own)	Dimensionless	This variable determines the energy demand associated with the marginal individual. The weights are based on the relative distance of the marginal individual with respect to the representative individual from the BMI group above it, and the representative individual from its own BMI group (Fallah-fini et al., 2013)
PA Fraction to PA Engagement				
	additions to Total PA Fraction A10, Gender	Maturation A10 to A11 by Gender*Physical Activity Environment.Fraction of Adolescents engaged in PA, Age 11 to 13, Gender	People/Years	This flow represents the number of younger adolescents that are engaged in PA. It is calculated by multiplying the number of adolescents entering the aging chain (turning 11 years old) and the percentage of adolescents engaged in PA.
	additions to Total PA Fraction A14, Gender	Maturation A11 to A13 by Gender*Physical Activity Environment.Fraction of Adolescents engaged in PA, Age 14 to 15, Gender	People/Years	This flow represents the number of older adolescents that are engaged in PA. It is calculated by multiplying the number of adolescents moving to the older adolescents' stock and the percentage of adolescents engaged in PA.

Variable Type	Variable Name	Equation	Unit	Description
	Average PA Fraction A11 to A13, Gender	Total PA Fraction A11 to A13/Population Age 11 to 13	Dimensionless	This variable represents the average PA fraction for younger adolescents. It is obtained by diving the stock of younger adolescents engaged in PA and the total population of younger adolescents.
	Average PA Fraction A14 to A15, Gender	Total PA Fraction A14 to A15/Population Age 14 to 15	Dimensionless	This variable represents the average PA fraction for older adolescents. It is obtained by diving the stock of older adolescents engaged in PA and the total population of older adolescents.
	Maturation A10 to A11 by Gender, Gender	SUM(maturation A10 to A11, *, Gender)	People/Years	This variable calculates the total number of younger adolescents divided by gender.
	Maturation A11 to A13 by Gender, Gender	SUM(maturation A11 to A13, *, Gender)	People/Years	This variable calculates the total number of younger adolescents divided by gender.
	Maturation A13 to A15 by Gender, Gender	SUM(maturation A13 to A15, *, Gender)	People/Years	This variable calculates the total number of older adolescents divided by gender.
	Total PA Fraction A11 to A13, Gender(t)	Total PA Fraction A11 to A13, Gender(t - dt) + (additions to Total PA Fraction A10, Gender - Total PA Fraction from A13 to A14, Gender) * dt	People	This is a stock variable that calculates the integrated difference between the number of adolescents turning 11 years old and the number of adolescents turning 14 years old. The initial value of the stock is the total population of adolescents aged 11 multiplied by the fraction of adolescents in PA.
	Total PA Fraction A14 to A15, Gender(t)	Total PA Fraction A14 to A15, Gender(t - dt) + (additions to Total PA Fraction A14, Gender - Total PA Fraction from A15 to A16, Gender) * dt	People	This is a stock variable that calculates the integrated difference between the number of adolescents turning 14 years old and the number of adolescents turning 16 years old. The initial value of the stock is the total population of adolescents aged 13 multiplied by the fraction of adolescents in PA.
	Total PA Fraction from A13 to A14, Gender	Maturation A11 to A13 by Gender*Average PA Fraction A11 to A13	People/Years	This flow represents the number of younger adolescents that are engaged in PA. It is calculated by multiplying the number of adolescents becoming older adolescents and the average of adolescents engaged in PA for younger adolescents.
	Total PA Fraction from A15 to A16, Gender	Maturation A13 to A15 by Gender*Average PA Fraction A14 to A15	People/Years	This flow represents the number of older adolescents that are engaged in PA. It is calculated by multiplying the number of adolescents exiting the aging chain adolescents and the average of adolescents engaged in PA for older adolescents.

Variable Type	Variable Name	Equation	Unit	Description
Total Population:				
◯	Normal Weight, Gender, Age Group	Population segmented by BMI gender and age group, Normal Weight, Gender, Age Group	People	This equation calculates the number of adolescents with normal weight by gender and age.
◯	Normal weight Fraction by Age, Gender, Age Group	Normal Weight/Population Total	Dimensionless	This equation calculates the fraction of adolescents with normal weight by gender and age.
◯	Obese, Gender, Age Group	Population segmented by BMI gender and age group, Obese, Gender, Age Group	People	This equation calculates the number of obese adolescents by gender and age.
◯	Obese All Ages, Gender	SUM(Obese, Gender, *)	People	This equation calculates the number of obese adolescents by gender.
◯	Obese Fraction All Ages, Gender	Obese All Ages/SUM(Population Total, Gender, *)	Dimensionless	This equation calculates the fraction of obese adolescents by gender.
◯	Obese Fraction by Age, Gender, Age Group	Obese/Population Total	Dimensionless	This equation calculates the obesity prevalence by age and gender in fractions.
◯	Overweight, Gender, Age Group	Population segmented by BMI gender and age group, Overweight, Gender, Age Group	People	This equation calculates the number of overweight adolescents by gender and age.
◯	Overweight All Ages, Gender	SUM(Overweight, Gender, *)	People	This equation calculates the number of overweight adolescents by gender.
◯	Overweight and Obese Fraction All Ages, Gender	Overweight Fraction All Ages+Obese Fraction All Ages	Dimensionless	This equation calculates the fraction of overweight and obese adolescents by gender.
◯	Overweight and Obese Fraction by Age, Gender, Age Group	Overweight Fraction by Age+Obese Fraction by Age	Dimensionless	This equation calculates the prevalence of overweight and obesity in fraction.
◯	Overweight Fraction All Ages, Gender	Overweight All Ages/SUM(Population Total, Gender, *)	Dimensionless	This equation calculates the fraction of overweight adolescents by gender.
◯	Overweight Fraction by Age, Gender, Age Group	Overweight/Population Total	Dimensionless	This equation calculates the overweight prevalence by age and gender in fractions.
◯	OWOB prevalence age&gender	100*(Total owob/Total pop)	Dimensionless	This is a variable that calculates the prevalence of overweight and obesity in adolescents as percentage. The equation converts fraction of prevalence to percentage.
◯	Population A11 by Gender, Gender	SUM(Population Age 11, *, Gender)	People	This equation calculates the total number of adolescents for 11-year-olds by gender category.
◯	Population A13 by Gender, Gender	SUM(Population Age 13, *, Gender)	People	This equation calculates the total number of adolescents for 13-year-olds by gender category.
◯	Population Age 11 to 13, Gender	SUM(Population Age 11, *, Gender)+SUM(Population Age 13, *, Gender)	People	This equation calculates the total number of younger adolescents (11 and 13-year-olds) by gender category.
◯	Population Age 14 to 15, Gender	SUM(Population Age 15, *, Gender)	People	This equation calculates the total number of older adolescents (15-year-olds) by gender category.

Variable Type	Variable Name	Equation	Unit	Description
○	Population Age 15 by Gender, Gender	SUM(Population Age 15, *, Gender)	People	This equation calculates the total number of adolescents for 15-year-olds by gender category.
○	Population INIT, BMI Group, Gender, Age Group	INIT(Population segmented by BMI gender and age group)	People	This equation calculates only the initial number of each category of the adolescents namely BMI, age and gender.
○	Population segmented by BMI gender and age group, Normal Weight, Male, Age 11	Population Age 11, Normal Weight, Male	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Normal Weight, Male, Age 13	Population Age 13, Normal Weight, Male	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Normal Weight, Male, Age 15	Population Age 15, Normal Weight, Male	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Normal Weight, Female, Age 11	Population Age 11, Normal Weight, Female	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Normal Weight, Female, Age 13	Population Age 13, Normal Weight, Female	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Normal Weight, Female, Age 15	Population Age 15, Normal Weight, Female	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Overweight, Male, Age 11	Population Age 11, Overweight, Male	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Overweight, Male, Age 13	Population Age 13, Overweight, Male	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Overweight, Male, Age 15	Population Age 15, Overweight, Male	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Overweight, Female, Age 11	Population Age 11, Overweight, Female	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Overweight, Female, Age 13	Population Age 13, Overweight, Female	People	This equation calculates the total number of each category of the adolescents

Variable Type	Variable Name	Equation	Unit	Description
				namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Overweight, Female, Age 15	Population Age 15, Overweight, Female	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Obese, Male, Age 11	Population Age 11, Obese, Male	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Obese, Male, Age 13	Population Age 13, Obese, Male	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Obese, Male, Age 15	Population Age 15, Obese, Male	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Obese, Female, Age 11	Population Age 11, Obese, Female	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Obese, Female, Age 13	Population Age 13, Obese, Female	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population segmented by BMI gender and age group, Obese, Female, Age 15	Population Age 15, Obese, Female	People	This equation calculates the total number of each category of the adolescents namely BMI, age and gender at any given time during the simulation.
○	Population SUM by Gender, Gender	SUM(Population segmented by BMI gender and age group, *, Gender, *)	People	This equation calculates the total number adolescents by gender.
○	Population Total, Gender, Age Group	SUM(Population segmented by BMI gender and age group, *, Gender, Age Group)	People	This equation calculates the total number of adolescents by gender and age category.
○	Total owob	Obese All Ages, Male+Obese All Ages, Female+Overweight All Ages, Male+Overweight All Ages, Female	People	This equation calculates the total number of overweight and obese adolescents.
○	Total pop	Population Total, Male, Age 11+Population Total, Male, Age 13+Population Total, Male, Age 15+Population Total, Female, Age 11+Population Total, Female, Age 13+Population Total, Female, Age 15	People	This equation calculates the total number of adolescents.
Body Weight Dynamics				
○	Ae, Male	3.2	kcal/day	This is a constant which indicates the parameter for calculation of growth function. It represents the required amount of kcal per day for physiological

Variable Type	Variable Name	Equation	Unit	Description
				processes during growth for each sex (Hall, 2013).
○	Ae, Female	2.3	kcal/day	This is a constant which indicates the parameter for calculation of growth function. It represents the required amount of kcal per day for physiological processes during growth for each sex (Hall, 2013).
○	Ae func, Gender, Age Group	Ae, Gender^exponA	kcal/day	This equation calculates the one part of the age-dependent growth function that represents the net caloric requirement for various physiological processes during growth (Hall, 2013). The equation indicates that the base caloric requirement for growth is raised to a power which represents the time that growth process is active and its magnitude. The exponent makes sure that as the time increases, the growth approaches zero (Hall, 2013).
○	Average EI per day, Gender, Age Group	Average EI year/365	kcal/day	This is a variable that represents the average energy intake of adolescents by age and gender per day.
○	Average EI year, Male, Age 11	(Energy Intake EI, Normal Weight, Male, Age 11+Energy Intake EI, Overweight, Male, Age 11+Energy Intake EI, Obese, Male, Age 11)/3	kcal/year	This is a variable that represents the average energy intake of adolescents by age and gender per year.
○	Average EI year, Male, Age 13	(Energy Intake EI, Normal Weight, Male, Age 13+Energy Intake EI, Overweight, Male, Age 13+Energy Intake EI, Obese, Male, Age 13)/3	kcal/year	This is a variable that represents the average energy intake of adolescents by age and gender per year.
○	Average EI year, Male, Age 15	(Energy Intake EI, Normal Weight, Male, Age 15+Energy Intake EI, Overweight, Male, Age 15+Energy Intake EI, Obese, Male, Age 15)/3	kcal/year	This is a variable that represents the average energy intake of adolescents by age and gender per year.
○	Average EI year, Female, Age 11	(Energy Intake EI, Normal Weight, Female, Age 11+Energy Intake EI, Overweight, Female, Age 11+Energy Intake EI, Obese, Female, Age 11)/3	kcal/year	This is a variable that represents the average energy intake of adolescents by age and gender per year.
○	Average EI year, Female, Age 13	(Energy Intake EI, Normal Weight, Female, Age 13+Energy Intake EI, Overweight, Female, Age 13+Energy Intake EI, Obese, Female, Age 13)/3	kcal/year	This is a variable that represents the average energy intake of adolescents by age and gender per year.
○	Average EI year, Female, Age 15	(Energy Intake EI, Normal Weight, Female, Age 15+Energy Intake EI, Overweight, Female, Age 15+Energy Intake EI, Obese, Female, Age 15)/3	kcal/year	This is a variable that represents the average energy intake of adolescents by age and gender per year.
○	Base EI, BMI Group, Gender, Age Group	EI numerator/EI denominator	kcal/year	This is a variable that represents the energy that body needs to conserve its current state in other words in order to not to lose weight or gain weight (Fallah-Fini et al., 2013; 2014)
○	base emotional eating consumption	50*365	kcal/year	This is constant that represents the base emotional consumption.

Variable Type	Variable Name	Equation	Unit	Description
				Its equation indicates that the base emotional consumption is 50 kcal per day, and it is multiplied by 365 days to convert the consumption to per year.
○	base energy expenditure	8000	kcal/year	This is a constant that represents the base energy expenditure for physical activity.
○	Be, Male	9.6	kcal/day	This is a constant which indicates the parameter for calculation of growth function. It represents the required amount of kcal per day for physiological processes during growth for each sex (Hall, 2013).
○	Be, Female	8.4	kcal/day	This is a constant which indicates the parameter for calculation of growth function. It represents the required amount of kcal per day for physiological processes during growth for each sex (Hall, 2013).
○	Be func, Gender, Age Group	Be, Gender^exponB	kcal/day	This equation calculates the one part of the age-dependent growth function that represents the net caloric requirement for various physiological processes during growth (Hall, 2013). The equation indicates that the base caloric requirement for growth is raised to a power which represents the time that growth process is active. The exponent makes sure that the as the time increases, the growth approaches zero (Hall, 2013).
○	Betta	0.24	Dimensionless	This is a constant that represents the adaptive thermogenesis parameter (Beta) which is the energy requirement per kcal after a change in diet (Hall, 2008; Hall et al., 2009; Hall, 2010).
○	Body Weight BW, BMI Group, Gender, Age Group	Fat Free Mass FFM+Fat Mass FM	kg	This is a variable that represents the total body mass of the individual. The equation indicates that the body weight is the sum of fat free mass and fat mass (Chow and Hall, 2008; Hall et al., 2009; Hall, 2010).
○	BWfactor, BMI Group, Gender, Age Group	Body Weight BW*Delta	kcal/year	This is a variable that represents the energy expenditure from physical activities. The equation indicates that energy expenditure from physical activities are proportional to the body weight based on the Delta which the physical activity

Variable Type	Variable Name	Equation	Unit	Description
				constant. (Chow and Hall, 2008; Hall et al., 2009; Hall, 2010).
○	C	10.4	kg	This is a constant that represents the Forbes' body composition coefficient (Chow and Hall, 2008; Hall et al., 2009; Hall, 2010). The number is the result of a parameterization by Forbes to fit the logarithmic function that Forbes is used to relate fat free mass to fat mass based on a cross-sectional data set (Forbes, 1987; Hall, 2008; 2010).
○	Caloric consumption, BMI Group, Gender, Age Group	INIT(Base EI)	Kcal/years	This is a variable that represents the caloric consumption of individuals. INIT function in its equation calculates the initial kcal of base energy intake in order to calculate the consumption variation.
○	CConstant, BMI Group, Gender, Age Group	C*RhoL teens/RhoF	kg	This is a constant that represents the parameter for the energy partitioning model (Forbes, 1987; Hall, 2007, 2010; Hall et al., 2009).
○	Consumption variation, BMI Group, Gender, Age Group	(Caloric consumption-Base EI) {STEP(100*365; 2)} {-STEP(100*190; 2)+STEP(100*365; 17)-STEP(100*230; 29)+STEP(100*310; 38) -STEP(100*135; 45)}	Kcal/year	This is a variable that represents the difference between the initial base energy requirement and base energy intake.
○	days in a year	365	day/years	This is a constant that represents the number of days in a year (Simon et al., 1994).
○	days per year	365	days/year	This is a constant that represents the number of days in a year (Simon et al., 1994).
○	De, Male	10.1	kcal/day	This is a constant which indicates the parameter for calculation of growth function. It represents the required amount of kcal per day for physiological processes during growth for each sex (Hall, 2013).
○	De, Female	1.1	kcal/day	This is a constant which indicates the parameter for calculation of growth function. It represents the required amount of kcal per day for physiological processes during growth for each sex (Hall, 2013).
○	De func, Gender, Age Group	De, Gender^expontD	kcal/day	This equation calculates the one part of the age-dependent growth function that represents the net caloric requirement for various physiological processes during growth (Hall, 2013).

Variable Type	Variable Name	Equation	Unit	Description
				The equation indicates that the base caloric requirement for growth is raised to a power which represents the time that growth process is active. The exponent makes sure that the as the time increases, the growth approaches zero (Hall, 2013).
○	Delta, BMI Group, Gender, Age Group	3*365*0+1*(days per year*Reference PAL*Physical Activity level)*1*PA switch +(1-PA switch)*Reference PAL*days per year	kcal/(kg*year)	This is variable that represents the physical activity coefficient which is the energy expenditure from physical activity per kg of body weight. The equation indicates that the physical activity coefficient is relying on physical activity level (Hall et al., 2009, Hall, 2010).
○	Delta per Day, BMI Group, Gender, Age Group	Delta/days per year	Kilocalories/(Days *kg)	This is variable that represents the physical activity coefficient which is the energy expenditure from physical activity per kg of body weight. The equation converts yearly value to daily value.
○	DeltaEnergyIntake, BMI Group, Gender, Age Group	Energy Intake EI-Base EI	kcal/year	This is a variable that represents the change in energy expenditure. The equation calculates the change in energy intake relying on base energy intake in order to calculate the adaptive thermogenesis (Hall et al., 2009; Hall, 2010).
○	dIfactor Delta EI, BMI Group, Gender, Age Group	Betta*DeltaEnergyIntake	kcal/year	This function represents the thermic effect of feeding relying on thermogenesis constant and energy intake. The equation indicates that the delta factor is the function of change in energy intake and the thermogenesis parameter (Hall, 2008; Hall et al., 2009; Hall, 2010).
○	EI denominator, BMI Group, Gender, Age Group	1-(IFactor)/(1+IFactor)	Dimensionless	This is a variable that represents the part of calculation for base energy requirement for the body in its current state. The equation indicates that this energy requirement is based on energy requirement for basic body functions (Fallah-Fini et al., 2013; 2014).
○	EI numerator, BMI Group, Gender, Age Group	(KConstant+FFMfactor+FMfactor+BWfactor)/(1+I Factor)	kcal/year	This function represents the part of calculation for base energy requirement for the body in its current state in other words indicates the maintenance of the

Variable Type	Variable Name	Equation	Unit	Description
				body weight. The equation is utilized to calculate the required energy intake to maintain steady state when there is a change in energy intake. Hence, the equation indicates that this energy requirement is based on RMR, constant k and expenditure from physical activity (Fallah-Fini et al., 2013; 2014).
◯	Unhealthy eating switch 1	1	Dimensionless	This is a control variable for the model that activates or deactivates emotional eating.
◯	Energy Expenditure EE, Normal Weight, Male, Age 11	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Male, Age 11)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions. The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.
◯	Energy Expenditure EE, Normal Weight, Male, Age 13	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Male, Age 13)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions. The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.
◯	Energy Expenditure EE, Normal Weight, Male, Age 15	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Male, Age 15)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions. The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.
◯	Energy Expenditure EE, Normal Weight, Female, Age 11	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Female, Age 11)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions.

Variable Type	Variable Name	Equation	Unit	Description
				The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.
○	Energy Expenditure EE, Normal Weight, Female, Age 13	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Female, Age 13)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions. The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.
○	Energy Expenditure EE, Normal Weight, Female, Age 15	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Female, Age 15)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions. The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.
○	Energy Expenditure EE, Overweight, Male, Age 11	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Male, Age 11)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions. The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.
○	Energy Expenditure EE, Overweight, Male, Age 13	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Male, Age 13)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions. The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.

Variable Type	Variable Name	Equation	Unit	Description
○	Energy Expenditure EE, Overweight, Male, Age 15	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Male, Age 15)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions. The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.
○	Energy Expenditure EE, Overweight, Female, Age 11	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Female, Age 11)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions. The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.
○	Energy Expenditure EE, Overweight, Female, Age 13	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Female, Age 13)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions. The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.
○	Energy Expenditure EE, Overweight, Female, Age 15	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Female, Age 15)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions. The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.
○	Energy Expenditure EE, Obese, Male, Age 11	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Male, Age 11)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions.

Variable Type	Variable Name	Equation	Unit	Description
				The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.
○	Energy Expenditure EE, Obese, Male, Age 13	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Male, Age 13)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions. The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.
○	Energy Expenditure EE, Obese, Male, Age 15	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Male, Age 15)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions. The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.
○	Energy Expenditure EE, Obese, Female, Age 11	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Female, Age 11)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions. The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.
○	Energy Expenditure EE, Obese, Female, Age 13	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Female, Age 13)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions. The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.

Variable Type	Variable Name	Equation	Unit	Description
○	Energy Expenditure EE, Obese, Female, Age 15	KConstant/(1+IFactor)+Energy Expenditure without K + (base energy expenditure*Mental Health.motivation to do PA multiplier, Female, Age 15)*Motivation to do PA Switch	kcal/year	This is a variable that represents the total energy expenditure per year for each age, sex and body weight group with k constant which is determined by the initial energy balance conditions. The equation includes the total energy expenditure without k constant and the calories that are used for physical activity under effect of motivation to do physical activity.
○	Energy Expenditure without K, BMI Group, Gender, Age Group	(FFMfactor+FMfactor+BWfactor+dlfactor Delta EI+Iterm+gfactor)/(1+IFactor)	kcal/year	This is a variable that represents the total energy expenditure per year without k constant which is determined by the initial energy balance conditions. The equation is the sum of energy requirement of the body such as for resting metabolic rate of fat free and fat mass, physical activity, thermic effect of foods, and adaptive thermogenesis.
○	Energy Intake EI, Normal Weight, Male, Age 11	(Average_Energy_Intake[Normal_Weight,Male,Age_11]*Adjusted_Consumption[Normal_Weight,Male,Age_11]*Food_switch) + (1-Food_switch)*(Base_EI[Normal_Weight,Male,Age_11] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Male,Age_11]-MW."Low_Appetite_(LA)_Multiplier"[Male,Age_11])))*unhealthy_eating_switch	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two part, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of average energy intake and the effect of food environment to energy intake. Second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Intake EI, Normal Weight, Male, Age 13	(Average_Energy_Intake[Normal_Weight,Male,Age_13]*Adjusted_Consumption[Normal_Weight,Male,Age_13]*Food_switch) + (1-Food_switch)*(Base_EI[Normal_Weight,Male,Age_13] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Male,Age_13]-MW."Low_Appetite_(LA)_Multiplier"[Male,Age_13])))*unhealthy_eating_switch	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two part, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of average energy intake and the effect of food environment to energy intake. Second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Intake EI, Normal Weight, Male, Age 15	(Average_Energy_Intake[Normal_Weight,Male,Age_15]*Adjusted_Consumption[Normal_Weight,Male,Age_15]*Food_switch) + (1-	kcal/year	This is a variable that represents the total energy intake of individuals per year.

Variable Type	Variable Name	Equation	Unit	Description
		Food_switch)*(Base_EI[Normal_Weight,Male,Age_15] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Male,Age_15]-MW."Low_Appetite_(LA)_Multiplier"[Male,Age_15])))*unhealthy_eating_switch		The equation indicates that energy intake has two parts, and the total energy intake is the sum of these two parts. The first part is calculated with the multiplication of average energy intake and the effect of food environment on energy intake. The second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Intake EI, Normal Weight, Female, Age 11	((Average_Energy_Intake[Normal_Weight,Female,Age_11]*Adjusted_Consumption[Normal_Weight,Female,Age_11]*Food_switch) + (1-Food_switch)*(Base_EI[Normal_Weight,Female,Age_11] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Female,Age_11]-MW."Low_Appetite_(LA)_Multiplier"[Female,Age_11])))*unhealthy_eating_switch	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two parts, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of average energy intake and the effect of food environment to energy intake. Second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Intake EI, Normal Weight, Female, Age 13	(Average_Energy_Intake[Normal_Weight,Female,Age_13]*Adjusted_Consumption[Normal_Weight,Female,Age_13]*Food_switch) + (1-Food_switch)*(Base_EI[Normal_Weight,Female,Age_13] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Female,Age_13]-MW."Low_Appetite_(LA)_Multiplier"[Female,Age_13])))*unhealthy_eating_switch	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two part, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of average energy intake and the effect of food environment to energy intake. Second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Intake EI, Normal Weight, Female, Age 15	(Average_Energy_Intake[Normal_Weight,Female,Age_15]*Adjusted_Consumption[Normal_Weight,Female,Age_15]*Food_switch) + (1-Food_switch)*(Base_EI[Normal_Weight,Female,Age_15] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Female,Age_15]-MW."Low_Appetite_(LA)_Multiplier"[Female,Age_15])))*unhealthy_eating_switch	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two part, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of average energy intake and the effect of food environment to energy intake. Second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.

Variable Type	Variable Name	Equation	Unit	Description
○	Energy Intake EI, Overweight, Male, Age 11	(Average_Energy_Intake[Overweight,Male,Age_11]*Adjusted_Consumption[Overweight,Male,Age_11]*Food_switch) + (1-Food_switch)*(Base_EI[Overweight,Male,Age_11] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Male,Age_11]-MW."Low_Appetite_(LA)_Multiplier"[Male,Age_11])))*unhealthy_eating_switch	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two part, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of average energy intake and the effect of food environment to energy intake. Second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Intake EI, Overweight, Male, Age 13	(Average_Energy_Intake[Overweight,Male,Age_13]*Adjusted_Consumption[Overweight,Male,Age_13]*Food_switch) + (1-Food_switch)*(Base_EI[Overweight,Male,Age_13] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Male,Age_13]-MW."Low_Appetite_(LA)_Multiplier"[Male,Age_13])))*unhealthy_eating_switch	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two part, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of average energy intake and the effect of food environment to energy intake. Second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Intake EI, Overweight, Male, Age 15	((Average_Energy_Intake[Overweight,Male,Age_15]*Adjusted_Consumption[Overweight,Male,Age_15]*Food_switch) + (1-Food_switch)*(Base_EI[Overweight,Male,Age_15] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Male,Age_15]-MW."Low_Appetite_(LA)_Multiplier"[Male,Age_15])))*unhealthy_eating_switch	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two part, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of average energy intake and the effect of food environment to energy intake. Second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Intake EI, Overweight, Female, Age 11	(Average_Energy_Intake[Overweight,Female,Age_11]*Adjusted_Consumption[Overweight,Female,Age_11]*Food_switch) + (1-Food_switch)*(Base_EI[Overweight,Female,Age_11] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Female,Age_11]-MW."Low_Appetite_(LA)_Multiplier"[Female,Age_11])))*unhealthy_eating_switch	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two part, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of average energy intake and the effect of food environment to energy intake. Second part represents the emotional eating. This part is calculated by the base

Variable Type	Variable Name	Equation	Unit	Description
				emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Intake EI, Overweight, Female, Age 13	(Average_Energy_Intake[Overweight,Female,Age_13]*Adjusted_Consumption[Overweight,Female,Age_13]*Food_switch) + (1-Food_switch)*(Base_EI[Overweight,Female,Age_13] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Female,Age_13]-MW."Low_Appetite_(LA)_Multiplier"[Female,Age_13])))*unhealthy_eating_switch	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two part, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of average energy intake and the effect of food environment to energy intake. Second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Intake EI, Overweight, Female, Age 15	(Average_Energy_Intake[Overweight,Female,Age_15]*Adjusted_Consumption[Overweight,Female,Age_15]*Food_switch) + (1-Food_switch)*(Base_EI[Overweight,Female,Age_15] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Female,Age_15]-MW."Low_Appetite_(LA)_Multiplier"[Female,Age_15])))*unhealthy_eating_switch	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two part, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of average energy intake and the effect of food environment to energy intake. Second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Intake EI, Obese, Male, Age 11	(Average_Energy_Intake[Obese,Male,Age_11]*Adjusted_Consumption[Obese,Male,Age_11]*Food_switch) + (1-Food_switch)*(Base_EI[Obese,Male,Age_11] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Male,Age_11]-MW."Low_Appetite_(LA)_Multiplier"[Male,Age_11])))*unhealthy_eating_switch	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two part, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of average energy intake and the effect of food environment to energy intake. Second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Intake EI, Obese, Male, Age 13	(Average_Energy_Intake[Obese,Male,Age_13]*Adjusted_Consumption[Obese,Male,Age_13]*Food_switch) + (1-Food_switch)*(Base_EI[Obese,Male,Age_13] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Male,Age_13]-MW."Low_Appetite_(LA)_Multiplier"[Male,Age_13])))*unhealthy_eating_switch	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two part, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of average energy intake and the effect of food environment to energy intake.

Variable Type	Variable Name	Equation	Unit	Description
				Second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Intake EI, Obese, Male, Age 15	(Average_Energy_Intake[Obese,Male,Age_15]*Adjusted_Consumption[Obese,Male,Age_15]*Food_switch) + (1-Food_switch)*(Base_EI[Obese,Male,Age_15] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Male,Age_15]-MW."Low_Appetite_(LA)_Multiplier"[Male,Age_15])))*unhealthy_eating_switch	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two part, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of average energy intake and the effect of food environment to energy intake. Second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Intake EI, Obese, Female, Age 11	(Average_Energy_Intake[Obese,Female,Age_11]*Adjusted_Consumption[Obese,Female,Age_11]*Food_switch) + (1-Food_switch)*(Base_EI[Obese,Female,Age_11] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Female,Age_11]-MW."Low_Appetite_(LA)_Multiplier"[Female,Age_11])))*unhealthy_eating_switch	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two part, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of average energy intake and the effect of food environment to energy intake. Second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Intake EI, Obese, Female, Age 13	(Average_Energy_Intake[Obese,Female,Age_13]*Adjusted_Consumption[Obese,Female,Age_13]*Food_switch) + (1-Food_switch)*(Base_EI[Obese,Female,Age_13] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Female,Age_13]-MW."Low_Appetite_(LA)_Multiplier"[Female,Age_13])))*unhealthy_eating_switch	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two part, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of average energy intake and the effect of food environment to energy intake. Second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Intake EI, Obese, Female, Age 15	(Average_Energy_Intake[Obese,Female,Age_15]*Adjusted_Consumption[Obese,Female,Age_15]*Food_switch) + (1-Food_switch)*(Base_EI[Obese,Female,Age_15] + Consumption_variation*Energy_Switch) + (Base_Emotional_Eating_Consumption*(1+(MW."Binge_Eating_(BE)_Multiplier"[Female,Age_15]-	kcal/year	This is a variable that represents the total energy intake of individuals per year. The equation indicates that energy intake has two part, and the total energy intake is the sum of these two parts. First part is calculated with the multiplication of

Variable Type	Variable Name	Equation	Unit	Description
		MW."Low_Appetite_(LA)_Multiplier"[Female,Age _15])))*unhealthy_eating_switch		average energy intake and the effect of food environment to energy intake. Second part represents the emotional eating. This part is calculated by the base emotional caloric consumption multiplied by the emotional eating multiplier.
○	Energy Partitioning Function Phi, BMI Group, Gender, Age Group	CConstant/(CConstant+Fat Mass FM)	Dimensionless	This dimensionless function represents the energy allocation within the body based on fat mass. It controls the relationship between FM and FFM (Hall, 2007). Its equation indicates how much energy is going to be used to produce fat free and fat tissue (Forbes, 1987, 2000; Hall, 2010; Hall et al., 2012)
○	Energy Switch	0	Dimensionless	This is control variable.
○	EtaF	180	kcal/kg	This is a constant that represents the energy cost for fat turnover which is proportional to change in fat mass (Hall, 2008; Hall et al., 2009; Hall, 2010).
○	EtaL	230	kcal/kg	This is a constant that represents the energy cost for protein turnover which is proportional to change in fat free mass (Hall, 2008; Hall et al., 2009; Hall, 2010).
○	exponA, Gender, Age Group	(-(t, Age Group-tA, Gender))/TauA, Gender	Dimensionless	This is a variable that represents the exponent of the parameter for growth function. The equation reflects the time that growth process occurs and after the adulthood reached, growth stops (Hall, 2013).
○	exponB, Gender, Age Group	((-(t, Age Group-tB, Gender)^2)/(2*(TauB, Gender)^2))	Dimensionless	This is a variable that represents the exponent of the parameter for growth function. The equation reflects the time that growth process occurs and after the adulthood reached, growth stops (Hall, 2013).
○	exponD, Gender, Age Group	((-(t, Age Group-tD, Gender)^2)/(2*(TauD, Gender)^2))	Dimensionless	This is a variable that represents the exponent of the parameter for growth function. The equation reflects the time that growth process occurs and after the adulthood reached, growth stops (Hall, 2013).
▭	Fat Free Mass FFM, BMI Group, Gender, Age Group(t)	Fat Free Mass FFM, BMI Group, Gender, Age Group(t - dt)	kg	This is a stock that represents the fat free mass in a person's body. It is defined by a stock because body mass

Variable Type	Variable Name	Equation	Unit	Description
				can accumulate within the time horizon of the model. Therefore, it is described by a differential equation.
	Fat Mass FM, BMI Group, Gender, Age Group(t)	Fat Mass FM, BMI Group, Gender, Age Group(t - dt)	kg	This is a stock that represents the fat free mass in a person's body. It is defined by a stock because body mass can accumulate within the time horizon of the model. Therefore, it is described by a differential equation.
	FFMfactor, BMI Group, Gender, Age Group	Fat Free Mass FFM*GammaL	kcal/year	This is a variable that represents the resting metabolic rate for fat free mass. This is the required energy for body to maintain its metabolic activities such as breathing, hear beats, cellular activities, protein, and hormonal syntheses and etc. (Chow and Hall, 2008; Hall et al., 2009; Hall, 2010). Its equation indicates that as the resting metabolic rate depends on the body mass. When it is increases, RMR increases and vice versa. The equation multiplied by 365 days to convert per day RMR to per year.
	FMfactor, BMI Group, Gender, Age Group	Fat Mass FM*GammaF	kcal/year	This is a variable that represents the resting metabolic rate for fat mass. This is the required energy for body to maintain its metabolic activities such as breathing, hear beats, cellular activities, protein and hormonal syntheses and etc. (Chow and Hall, 2008; Hall et al., 2009; Hall, 2010). Its equation indicates that as the resting metabolic rate depends on the body mass. When it is increases, RMR increases and vice versa. The equation multiplied by 365 days to convert per day RMR to per year.
	Food switch	1	Dimensionless	This is a control variable for the model that activates or deactivates the effect of food environment.
	Fraction of Adolescents in PA INIT, Age Band, Gender	INIT(Physical Activity Environment.Fraction of Adolescents engaged in PA)	Dimensionless	This is a variable that represents the caloric consumption of individuals. INIT function in the equation calculates the initial fraction of adolescents who engage in physical activities.
	Fraction PAL Active, Age 11, Male	Physical Activity Environment.Fraction of Adolescents engaged in PA, Age 11 to 13, Male	Dimensionless	This is a variable that represents the fraction of people who engage in physical activities.

Variable Type	Variable Name	Equation	Unit	Description
○	Fraction PAL Active, Age 11, Female	Physical Activity Environment.Fraction of Adolescents engaged in PA, Age 11 to 13, Female	Dimensionless	This is a variable that represents the fraction of people who engage in physical activities.
○	Fraction PAL Active, Age 13, Male	Physical Activity Environment.Fraction of Adolescents engaged in PA, Age 11 to 13, Male	Dimensionless	This is a variable that represents the fraction of people who engage in physical activities.
○	Fraction PAL Active, Age 13, Female	Physical Activity Environment.Fraction of Adolescents engaged in PA, Age 11 to 13, Female	Dimensionless	This is a variable that represents the fraction of people who engage in physical activities.
○	Fraction PAL Active, Age 15, Male	Physical Activity Environment.Fraction of Adolescents engaged in PA, Age 14 to 15, Male	Dimensionless	This is a variable that represents the fraction of people who engage in physical activities.
○	Fraction PAL Active, Age 15, Female	Physical Activity Environment.Fraction of Adolescents engaged in PA, Age 14 to 15, Female	Dimensionless	This is a variable that represents the fraction of people who engage in physical activities.
○	"g(t)", Gender, Age Group	Ae func+Be func+De func	kcal/day	This is a time-dependent equation that indicates the age-dependent growth function which represents the net effect of multiple physiological processes during growth (Hall, 2013).
○	GammaF	3.2*365	kcal/(kg*year)	This is a constant that represents the resting metabolic rate regression coefficient per fat mass (Nelson et al., 1992; Hall, 2010; Hall et al., 2009).
○	GammaL	22*365	kcal/(kg*year)	This is a constant that represents the resting metabolic rate regression coefficient per fat free mass (Nelson et al., 1992; Hall, 2010; Hall et al., 2009).
○	gfactor, BMI Group, Gender, Age Group	"g(t)", Gender, Age Group*((EtaL/RhoL teens) - (EtaF/RhoF))*days in a year	kcal/year	This is a variable that represents the difference between The equation indicates that the
○	IFactor, BMI Group, Gender, Age Group	EtaF*(1-Energy Partitioning Function Phi)/RhoF+EtaL*Energy Partitioning Function Phi/RhoL teens	Dimensionless	This is a variable that represents the energy required for fat and protein turnover for fat mass and fat free mass respectively. The equation indicates that the energy required for fat turnover and the protein turnover is calculated relying on the change in fat and fat free mass and multiplication of their corresponding parameter values (Hall, 2008; Hall et al., 2009; Hall, 2010).
○	"Indicated BW dBW/dt", BMI Group, Gender, Age Group	"Indicated dFM dFM/dt"+"Indicated dFFM dFFM/dt"	kg/year	This is a variable that represents the change in body weight composition. Its equation indicates that the change in body composition is the sum of change in fat free body mass and change in fat mass.

Variable Type	Variable Name	Equation	Unit	Description
○	"Indicated dFFM dFFM/dt", BMI Group, Gender, Age Group	Energy Partitioning Function Phi*(Energy Intake EI-Energy Expenditure EE)/RhoL teens	kg/year	This is a variable which is the energy partitioning function that represents the change in fat free mass based on energy balance or imbalance. When there is positive or negative energy imbalance, the stocks are added or depleted respectively. The equation indicates that energy imbalance is divided between fat free mass and fat mass which determines the body weight composition and the energy balance controls the magnitude of this change (Forbes, 1987, 2000; Hall, 2010; Hall et al., 2012).
○	"Indicated dFM dFM/dt", BMI Group, Gender, Age Group	(1-Energy Partitioning Function Phi)*(Energy Intake EI-Energy Expenditure EE)/RhoF	kg/year	This is a variable which is the energy partitioning function that represents the change in fat mass based on energy balance or imbalance. When there is positive or negative energy imbalance, the stocks are added or depleted respectively. The equation indicates that energy imbalance is divided between fat free mass and fat mass which determines the body weight composition and the energy balance controls the magnitude of this change (Forbes, 1987, 2000; Hall, 2010; Hall et al., 2012).
○	Iterm, BMI Group, Gender, Age Group	Energy Intake EI*IFactor	kcal/year	This is a variable that represents the thermic of food consumption which is the required amount of calories to absorb, digest and metabolize food. The equation calculates the how much calorie is needed for food digestion, metabolization and absorption
○	KConstant	370.21*365	kcal/year	This is a constant that is determined by the initial energy balance conditions (Chow and Hall, 2008; Hall et al., 2009; Hall, 2010).
○	Motivation to do PA Switch	1	Dimensionless	This is a control variable for the model that activates or deactivates motivation to do physical activity.
○	PA switch	1	Dimensionless	This is a control variable for the model that activates or deactivates physical activity engagement.
○	PAL Active, Normal Weight	1.5	Dimensionless	This is a constant that represents the average physical activity level of adolescents who are active (FAO, 2004).

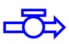
Variable Type	Variable Name	Equation	Unit	Description
○	PAL Active, Overweight	1.5	Dimensionless	This is a constant that represents the average physical activity level of adolescents who are active (FAO, 2004).
○	PAL Active, Obese	1.5	Dimensionless	This is a constant that represents the average physical activity level of adolescents who are active (FAO, 2004).
○	PAL Not Active, Normal Weight	1	Dimensionless	This is a constant that represents the average physical activity level of adolescents who are not active (FAO, 2004).
○	PAL Not Active, Overweight	1	Dimensionless	This is a constant that represents the average physical activity level of adolescents who are not active (FAO, 2004).
○	PAL Not Active, Obese	1	Dimensionless	This is a constant that represents the average physical activity level of adolescents who are not active (FAO, 2004).
○	PAL Reference Hall, Normal Weight, Male, Age 11	PAL Active, Normal Weight*Fraction PAL Active, Age 11, Male+PAL Not Active, Normal Weight*(1-Fraction PAL Active, Age 11, Male)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
○	PAL Reference Hall, Normal Weight, Male, Age 13	PAL Active, Normal Weight*Fraction PAL Active, Age 13, Male+PAL Not Active, Normal Weight*(1-Fraction PAL Active, Age 13, Male)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
○	PAL Reference Hall, Normal Weight, Male, Age 15	PAL Active, Normal Weight*Fraction PAL Active, Age 15, Male+PAL Not Active, Normal Weight*(1-Fraction PAL Active, Age 15, Male)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
○	PAL Reference Hall, Normal Weight, Female, Age 11	PAL Active, Normal Weight*Fraction PAL Active, Age 11, Female+PAL Not Active, Normal Weight*(1-Fraction PAL Active, Age 11, Female)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
○	PAL Reference Hall, Normal Weight, Female, Age 13	PAL Active, Normal Weight*Fraction PAL Active, Age 13, Female+PAL Not Active, Normal Weight*(1-Fraction PAL Active, Age 13, Female)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
○	PAL Reference Hall, Normal Weight, Female, Age 15	PAL Active, Normal Weight*Fraction PAL Active, Age 15, Female+PAL Not Active, Normal Weight*(1-Fraction PAL Active, Age 15, Female)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
○	PAL Reference Hall, Overweight, Male, Age 11	PAL Active, Overweight*Fraction PAL Active, Age 11, Male+PAL Not Active, Overweight*(1-Fraction PAL Active, Age 11, Male)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
○	PAL Reference Hall, Overweight, Male, Age 13	PAL Active, Overweight*Fraction PAL Active, Age 13, Male+PAL Not Active, Overweight*(1-Fraction PAL Active, Age 13, Male)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
○	PAL Reference Hall, Overweight, Male, Age 15	PAL Active, Overweight*Fraction PAL Active, Age 15, Male+PAL Not Active, Overweight*(1-Fraction PAL Active, Age 15, Male)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
○	PAL Reference Hall, Overweight, Female, Age 11	PAL Active, Overweight*Fraction PAL Active, Age 11, Female+PAL Not Active, Overweight*(1-Fraction PAL Active, Age 11, Female)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.

Variable Type	Variable Name	Equation	Unit	Description
◯	PAL Reference Hall, Overweight, Female, Age 13	PAL Active, Overweight*Fraction PAL Active, Age 13, Female+PAL Not Active, Overweight*(1-Fraction PAL Active, Age 13, Female)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
◯	PAL Reference Hall, Overweight, Female, Age 15	PAL Active, Overweight*Fraction PAL Active, Age 15, Female+PAL Not Active, Overweight*(1-Fraction PAL Active, Age 15, Female)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
◯	PAL Reference Hall, Obese, Male, Age 11	PAL Active, Obese*Fraction PAL Active, Age 11, Male+PAL Not Active, Obese*(1-Fraction PAL Active, Age 11, Male)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
◯	PAL Reference Hall, Obese, Male, Age 13	PAL Active, Obese*Fraction PAL Active, Age 13, Male+PAL Not Active, Obese*(1-Fraction PAL Active, Age 13, Male)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
◯	PAL Reference Hall, Obese, Male, Age 15	PAL Active, Obese*Fraction PAL Active, Age 15, Male+PAL Not Active, Obese*(1-Fraction PAL Active, Age 15, Male)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
◯	PAL Reference Hall, Obese, Female, Age 11	PAL Active, Obese*Fraction PAL Active, Age 11, Female+PAL Not Active, Obese*(1-Fraction PAL Active, Age 11, Female)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
◯	PAL Reference Hall, Obese, Female, Age 13	PAL Active, Obese*Fraction PAL Active, Age 13, Female+PAL Not Active, Obese*(1-Fraction PAL Active, Age 13, Female)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
◯	PAL Reference Hall, Obese, Female, Age 15	PAL Active, Obese*Fraction PAL Active, Age 15, Female+PAL Not Active, Obese*(1-Fraction PAL Active, Age 15, Female)	Dimensionless	This is a variable that represents the current level of physical activity of adolescents by gender and age.
◯	Physical Activity level, BMI Group, Gender, Age Group	PAL Reference Hall {0, 5}	Dimensionless	This is a variable that represents the daily physical activity of adolescents that is used to calculate energy expenditure from physical activity.
◯	Reference PAL	7	kcal/(kg*day)	This is a constant that represents the reference or initial physical activity coefficient. The value is an approximation of physical activity of a person who is sedentary (Hall et al., 2009, Hall, 2010).
◯	RhoF	9400	kcal/kg	This is a constant that represents the energy density or content of fat tissue (Hall, 2010; Hall et al., 2009).
◯	RhoL teens, BMI Group, Gender, Age Group	RhoLteens coef1*Fat Free Mass FFM+RhoLteens coef2	kcal/kg	This is a variable that represents the energy density or content of fat free tissue for teens (Hall, 2013). The equation indicates the teen fat free mass is not a constant but a variable due to growth factor. In other words, fat free energy density increases by age because of greater hydration of fat-free mass and body protein (Hall, 2013).

Variable Type	Variable Name	Equation	Unit	Description
○	RhoLteens coef1	4.3	kcal/kg^2	This is a constant that represents the coefficient for calculation of fat free body mass energy density (Hall, 2013).
○	RhoLteens coef2	837	kcal/kg	This is a constant that represents the coefficient for calculation of fat free body mass energy density (Hall, 2013).
○	t, Age 11	11	Years	This is a constant that represents the time (age) for the calculation of time dependent growth function (Hall, 2013).
○	t, Age 13	13	Years	This is a constant that represents the time (age) for the calculation of time dependent growth function (Hall, 2013).
○	t, Age 15	15	Years	This is a constant that represents the time (age) for the calculation of time dependent growth function (Hall, 2013).
○	tA, Male	4.7	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood (Hall, 2013).
○	tA, Female	4.5	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood (Hall, 2013).
○	TauA, Male	2.5	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood (Hall, 2013).
○	TauA, Female	1	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood (Hall, 2013).
○	TauB, Male	1	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood (Hall, 2013).
○	TauB, Female	0.9	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood (Hall, 2013).
○	TauD, Male	1.5	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood (Hall, 2013).
○	TauD, Female	0.7	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood (Hall, 2013).
○	tB, Male	12.5	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood (Hall, 2013).
○	tB, Female	11.7	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood (Hall, 2013).
○	tD, Male	15	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood (Hall, 2013).

Variable Type	Variable Name	Equation	Unit	Description
○	tD, Female	16.2	Years	This is a constant that represents the parameter of time that limits the growth with reaching adulthood (Hall, 2013).
Food Environment				
Demand				
○	Attribute Elasticity, Taste	4	Dimensionless	This is a constant that represents the elasticity of food attributes for food. These values are the relative sensitivity of consumers to change in food attributes and they reflect relatively strong sensitivity towards to motivational quality compared to nutritional quality. Elasticity of taste is positive because consumers' behavior towards to change in taste is directly proportional to change in demand or consumption (Struben et al., 2014).
○	Attribute Elasticity, Availability	4	Dimensionless	This is a constant that represents the elasticity of food attributes for food. These values are the relative sensitivity of consumers to change in food attributes and they reflect relatively strong sensitivity towards to motivational quality compared to nutritional quality. Elasticity of availability is positive because consumers' behavior towards to change in availability is directly proportional to change in demand or consumption (Struben et al., 2014).
○	Attribute Elasticity, Price	-4	Dimensionless	This is a constant that represents the elasticity of food attributes for food. These values are the relative sensitivity of consumers to change in food attributes and they reflect relatively strong sensitivity towards to motivational quality compared to nutritional quality. Elasticity of price is negative because consumers' behavior towards to change in price is inversely proportional to change in demand or consumption (Struben et al., 2014).
○	Attribute Utility, Category, Attribute	(Effective Attribute-1)*Attribute Elasticity, Attribute	Dimensionless	This is a variable that represents consumers' utility from the attributes of the food for each of the food category. The equation indicates that the consumers' effective utility changes by the attribute-

Variable Type	Variable Name	Equation	Unit	Description
				related elasticity of demand which reflects the consumers' consumption reaction to a change in the attributes. It is assumed that the consumers are more sensitive to change in these attributes than nutritional quality (Struben et al., 2014).
○	Caloric Density, Category	1/Nutritional quality	Dimensionless	This is a variable that represents the density of the food categories. It is assumed that low nutritious food has more caloric density (Pellegrini and Fogliano, 2017).
○	Category Attractiveness, Category	Consumer Category Utility^(1-Relative Importance of familiarity)*Familiarity with Food Category^Relative Importance of familiarity	Dimensionless	This is a variable that represents the attractiveness of the food category to individuals. The equation indicates that the consumer category utility (consumer affinity) depends on the familiarity with the food category in order to capture the effect of individual or social exposure on consumer category utility (Struben et al., 2014). It is calculated by a power function weighted by the relative importance of familiarity.
○	Category Market Share, Category	Category Attractiveness/SUM(Category Attractiveness)	Dimensionless	This is a variable that represents the market share of the food category. The equation calculates the market share of the food type by calculating the portion that type holds within the total attractiveness.
○	"Category Utility from Non-Nutritional Attributes", Category	EXP(SUM(Attribute Utility, Category, *))	Dimensionless	This is a variable that represents the utility of the food category related to non-nutritional attributes of food. EXP in the equation raises the base of natural logarithm, e, to the attribute utility.
○	Category Utility from Nutritional quality, Category	EXP(Nutritional quality)	Dimensionless	This is a constant that represents the utility of the food category from nutritional category. EXP in the equation raises the base of natural logarithm, e, to the nutritional quality.
▭	Change in Portion Size Indicated by Portion Size Multiplier	IF No Policy Switch=0 THEN SMTH1(STEP(Gap for Portion Size Policy*Portion Size Policy Multiplier, Portion Size Policy YEAR)-STEP(Gap for Portion Size Policy*Portion Size Policy Multiplier, Portion Size Policy YEAR+Portion Policy Duration), Time to Change Portion Size, 0) ELSE 0	Kilocalories/serving	This is a stock that represents the current information about the change in portion size. It is defined by a stock because information about portion size can

Variable Type	Variable Name	Equation	Unit	Description
				accumulate over the time horizon of the model. Therefore, it is described by an integral equation. The SMTH1 function indicates a first order information delay that represents the process of changing the information about the portion size via comparing its current and previous values.
◯	Consumer Category Utility, Category	"Category Utility from Non-Nutritional Attributes"^(1-Relative Importance of Nutritional quality)*Category Utility from Nutritional quality^Relative Importance of Nutritional quality	Dimensionless	This variable represents the consumer utility given both the non-nutritional attributes and the nutritional quality attribute of each food category. It is calculated by a power function weighted by the relative importance of both types of attributes.
◯	Consumption per Day	Consumption per meal total*Servings per Day	Kilocalories/(Days *People)	This is a variable that represents the caloric consumption per day. The equation multiplies number of meals per day with calories per meal to calculate the total consumption per day.
◯	Consumption per day ratio	Consumption per Day/INIT(Consumption per Day)	Dimensionless	This is a variable that represents the change in consumption.
◯	Consumption per meal by Category, Category	Portion Size*Category Market Share*Caloric Density	Kilocalories/serving	This is a variable that represents the number of calories that are consumed from each food category per day.
◯	Consumption per meal total	SUM(Consumption per meal by Category)	Kilocalories/serving	This is a variable that represents the total calories that each meal consists of. The equation sums all the calories from both food categories in a meal.
◯	Education Policy Duration	5	Years	This is a constant that represents how long the policy will be effective.
◯	Education Policy YEAR	2022	Years	This is a constant that represents the inception year of the policy.
◯	Exposure Decay Point	0.35	Dimensionless	This is a constant that represents the limit of decay for familiarity. Above this value, familiarity does not decay (Struben et al., 2014).
	familiarity decrease rate, Category	MAX(0, 1-Familiarity with Food Category/Exposure Decay Point)/Normal Familiarity Decay Time*SWITCH Social Exposure	Dimensionless/year	This is an outflow to Familiarity with Food Category that represents the rate of decrease in familiarity over time. The equation adjusts the decrease rate of familiarity with food category. The MAX function makes sure that the numerator of the equation to not go below zero so the lowest value it can get is 0 which means no decrease in familiarity. The denominator of

Variable Type	Variable Name	Equation	Unit	Description
				the equation indicates the time it takes familiarity to decay.
	familiarity increase rate, Category	(1-Familiarity with Food Category)*Social Exposure*SWITCH Social Exposure	Dimensionless/year	This is the inflow to familiarity with food category that represents the rate of increase in familiarity. The equations indicates that when familiarity reaches 1, familiarity stops increasing. Below that value, familiarity increases with social exposure and current value of familiarity.
	Familiarity with Food Category, Category(t)	Familiarity with Food Category, Category(t - dt) + (familiarity increase rate, Category - familiarity decrease rate, Category) * dt	Dimensionless	This is a stock that represents the affinity of consumers to the food category. It is defined by a stock because consumer affinity can accumulate within the time horizon of the model. Therefore, it is described by an integral equation.
	Gap for Portion Size Policy	MAX(Consumption per meal total-Desired consumption per meal, 0)	Kilocalories/serving	This is a variable that represents the gap between the desired consumption and actual consumption. The equation calculates this gap and MAX function in the equation makes sure that the gap never goes below zero.
	HN Education Policy Multiplier	0.10	Dimensionless	This is a constant that represents the magnitude of the policy as an aggregate term that includes political support, commitment of the policy makers, allocation of budget and etc.
	Indicated Relative Importance of Nutritional quality	IF No Policy Switch=0 THEN Relative Importance of Nutritional quality INIT+STEP(HN Education Policy Multiplier*Remaining Potential for Relative Importance of Nutritional quality, Education Policy YEAR)*1-STEP(HN Education Policy Multiplier*Remaining Potential for Relative Importance of Nutritional quality, Education Policy YEAR+Education Policy Duration) ELSE Relative Importance of Nutritional quality INIT	Dimensionless	This is a variable that represents the goal for the relative importance of the nutritional quality.
	Market Share, Category	Category Market Share*100	Dimensionless	This is a variable that represents the market share of the food categories. The equation converts decimal to percentage.
	No Policy Switch	0	Dimensionless	This is a control variable that activates or deactivates the policies.
	Normal Familiarity Decay Time	2	Years	This is a constant that represents the time it takes familiarity to decrease (Struben et al., 2014).
	Nutritional quality, High Nutritious	1	Dimensionless	This is a constant that represents the nutritional quality of the food type.

Variable Type	Variable Name	Equation	Unit	Description
○	Nutritional quality, Low Nutritious	1/1.6		This is a constant that represents the nutritional quality of the food type.
○	Portion Policy Duration	5	Years	This is a constant that represents how long the policy will be effective.
○	Portion Size	{IF(Portion Size Policy Multiplier<1) THEN(Reference Serving INIT*(1-Portion Size Policy Multiplier)) ELSE(0, 99)} Portion Size INIT-Change in Portion Size Indicated by Portion Size Multiplier	Kilocalories/serving	This is a variable that represents the portion size per meal. The equation indicates that there is an initial portion size which determines the portion size per meal. In addition to that, with the activation of the policy regarding the portion size, portion size is reducing by the amount of policy multiplier.
○	Portion Size INIT	366	Kilocalories/serving	This is a constant that represents the average initial calories per portion (Struben et al., 2014).
○	Portion Size Policy Multiplier	0.10	Dimensionless	This is a constant that represents the magnitude of the policy as an aggregate term that includes political support, commitment of the policy makers, allocation of budget and etc.
○	Portion Size Policy YEAR	2022	Dimensionless	This is a constant that represents the inception year of the policy.
○	Relative Importance of familiarity	0.5	Dimensionless	This is a constant that represents the weight of familiarity relative to actual affinity in consumer choice (Struben et al., 2014).
▭	Relative Importance of Nutritional quality	SMTH1(Indicated Relative Importance of Nutritional quality, Time to Change Relative Importance of Nutritional quality)	Dimensionless	This is a stock that represents the current perception about the nutritional quality to be allocated to the food category. It is defined by a stock because perception about nutritional quality can accumulate over the time horizon of the model. Therefore, it is described by an integral equation. The SMTH1 function indicates a first order information delay that represents the process of changing the information about the nutritional quality via comparing its current and previous values.
○	Relative Importance of Nutritional quality INIT	0.7	Dimensionless	This is a constant that represents the importance of the nutritional quality for consumers (Struben et al., 2014).
○	Remaining Potential for Relative Importance of Nutritional quality	1-Relative Importance of Nutritional quality INIT	Dimensionless	This is a constant that represents the remaining importance of nutritional quality (Struben et al., 2014).
○	Servings per Day	5	serving/day/person	This is a constant that represents the number of servings per day per person

Variable Type	Variable Name	Equation	Unit	Description
	Social Exposure, Category	Category Market Share*Social Exposure Effectiveness	Dimensionless/year	This is a variable that represents the social exposure of consumers to the food category. The equation indicates that the social exposure depends on the change in market share of the category.
	Social Exposure Effectiveness	0.1	Dimensionless/year	This is a constant that represents the magnitude of social exposure effectiveness (Struben et al., 2014).
	SWITCH Social Exposure	1	Dimensionless	This is a control variable that activates or deactivates the social exposure.
	Time to Change Portion Size	3	Years	This is a constant that represents the time it takes to policy to reach maximum effectiveness.
	Time to Change Relative Importance of Nutritional quality	5	Years	This is a constant that represents the time it takes to policy to reach maximum effectiveness.
Supply				
	Attribute Budget Share, Category, Attribute	SMTH1(Indicated Attribute Budget Share+STEP(Attribute Budget Share EXG-Attribute Budget Share INIT, 2022), Time to Adjust Budget, Attribute Budget Share INIT)	Dimensionless	This is a stock that represents the current information about the budget share to be allocated to improvement of attribute-related firm capabilities. It is defined by a stock because information about budget share is updated based on its previous value. Therefore, it is described by an integral equation. The SMTH1 function indicates a first order information delay that represents the process of changing the information about the budget share via comparing its current and previous values. Purpose of the STEP function in the equation is only for the testing the model. In the default setting, it has no effect on the behavior of the system.
	Attribute Budget Share EXG, Category, Attribute	1/3	Dimensionless	This parameter represents the portion of allocated budget of each food category and each food attribute. Each attribute has equal share of the budget, initially.
	Attribute Budget Share INIT, Category, Attribute	1/3	Dimensionless	This parameter represents the initial portion of the budget of each food category and each food attribute. Each attribute has equal share of the budget, initially.

Variable Type	Variable Name	Equation	Unit	Description
	Budget Share HN INIT	0.01*BudgetShare1	Dimensionless	This parameter represents the initial allocated budget share to High Nutritious food. It is them multiplied by the variable Budget Share 1 which allows users in an interface to modify the allocated budget to HN food.
	Budget to Attributes, Category, Attribute	Budget to Category, Category*Attribute Budget Share	NOK/Days	This variable calculates the allocated budget to food attributes. It is calculated by multiplying the budget allocated for each food category and the allocated budget share for each food attribute.
	Budget to Category, Category	Revenue*Category Budget Share	NOK/Days	This is a variable that represents the available budget to be allocated to improve capabilities.
	BudgetShare1	50		This variable allows users in an interface to modify the allocated budget to HN food.
	Capabilities, Category, Attribute(t)	Capabilities, Category, Attribute(t - dt) + (increase in capabilities, Category, Attribute) * dt	Dimensionless	This is a stock variable that calculates the capabilities of the food industry at each point in time. It can be considered as the investments or resources (money, R&D, human resources) that the food industry does to develop those capabilities. It is based on the initial value of capabilities plus the inflow that make capabilities increase.
	Capabilities INIT, High Nutritious, Taste	1	Dimensionless	This is a constant that represents the initial value of attributes of the food category (Struben et al., 2014).
	Capabilities INIT, High Nutritious, Availability	1	Dimensionless	This is a constant that represents the initial value of attributes of the food category (Struben et al., 2014).
	Capabilities INIT, High Nutritious, Price	1	Dimensionless	This is a constant that represents the initial value of attributes of the food category (Struben et al., 2014).
	Capabilities INIT, Low Nutritious, Taste	1	Dimensionless	This is a constant that represents the initial value of attributes of the food category (Struben et al., 2014).
	Capabilities INIT, Low Nutritious, Availability	1	Dimensionless	This is a constant that represents the initial value of attributes of the food category (Struben et al., 2014).
	Capabilities INIT, Low Nutritious, Price	1	Dimensionless	This is a constant that represents the initial value of attributes of the food category (Struben et al., 2014).
	Category Budget Share, Category	SMTH1(Indicated Category Budget Share+STEP(Category Budget Share EXG-Category Budget Share INIT, 2022), Time to Adjust Budget, Category Budget Share INIT)	Dimensionless	This is a stock that represents the current information about the budget share to be allocated to the food category. It is defined by a stock because information about budget share is updated based on its previous value. Therefore, it is

Variable Type	Variable Name	Equation	Unit	Description
				described by an integral equation. The SMTH1 function indicates a first order information delay that represents the process of changing the information about the budget share via comparing its current and previous values. Purpose of the STEP function in the equation is only for the testing the model. In the default setting, it has no effect on the behavior of the system.
◯	Category Budget Share EXG, High Nutritious	0.50	Dimensionless	This is a constant that represents the test value for the budget share.
◯	Category Budget Share EXG, Low Nutritious	0.50	Dimensionless	This is a constant that represents the test value for the budget share.
◯	Category Budget Share INIT, High Nutritious	Budget Share HN INIT	Dimensionless	This is a constant that represents the initial budget share to be allocated to the high nutritious food category. The equation indicates that the total budget cannot be more than 1 which represents the 100% of the budget.
◯	Category Budget Share INIT, Low Nutritious	1-Budget Share HN INIT		This is a constant that represents the initial budget share for the low nutritious food category. The equation indicates that the low nutritious category takes the remaining budget share after the high nutritious food category.
◯	Category Price, Category	Effective Attribute, Category, Price*Reference Price	NOK/Kilocalories	This is a variable that represents the hypothetical price of food category to calculate the effect of change in price as an attribute. The price changes based on the reference or initial price.
◯	Category Revenues, Category	Sales*Category Market Share*Category Price	NOK/Days	This is a variable that represents the revenue for the food category generates per day.
◯	Desired Attribute Budget, Category, Attribute	Budget to Attributes*(1+Marginal Benefit of Budget to Attribute)	NOK/Days	This is a variable that represents the desired budget wanted to be allocated to improvement of attribute-related capabilities. The current budget is adjusted according to this budget. The equation indicates that the desired attribute budget directly proportional to marginal benefit of the budget.
◯	Desired Budget to Category, Category	Budget to Category*(1+Marginal Benefit of Budget to Category)	NOK/Days	This is a variable that represents the desired budget wanted to be allocated to

Variable Type	Variable Name	Equation	Unit	Description
				the food category in order to improve the attributes. The current budget is adjusted according to this budget. The equation indicates that the desired category budget directly proportional to marginal benefit of the category budget.
○	Effect of Capabilities, Category, Attribute	(Capabilities/Capabilities INIT)^Learning Exponent, Attribute	Dimensionless	This variable determines a learning curve calculated by the capabilities initial value powered to a learning exponent so the food attribute utilities will grow based on the investment in capabilities. The equation represents the standard learning curve theory with diminishing returns (Struben et al., 2014).
○	Effect of LN Food Price Policy	IF No Policy Switch=0 THEN 0+STEP(LN Food Price for Food Price Policy*LN Food Price Policy Multiplier/Reference Price, Food Policy YEAR)*1-STEP(LN Food Price for Food Price Policy*LN Food Price Policy Multiplier/Reference Price, Food Policy YEAR+Price Policy Duration) ELSE 0	Dimensionless	This is a variable that represents the effect of low nutrition price policy on effective attribute value of price. The equation calculates the relative value of the price of low nutritious food after the implementation.
○	Effect of Marketing Policy on Attribute, High Nutritious, Taste	1	Dimensionless	This is a variable that represents the effect of low nutritious food marketing policy on effective attribute value of availability of low nutritious food. Since this policy only influences the availability of low nutritious food, it has no effect on other attributes and food categories.
○	Effect of Marketing Policy on Attribute, High Nutritious, Availability	1	Dimensionless	This is a variable that represents the effect of low nutritious food marketing policy on effective attribute value of availability of low nutritious food.
○	Effect of Marketing Policy on Attribute, High Nutritious, Price	1	Dimensionless	This is a variable that represents the effect of low nutritious food marketing policy on effective attribute value of price of low nutritious food.
○	Effect of Marketing Policy on Attribute, Low Nutritious, Taste	1	Dimensionless	This is a variable that represents the effect of low nutritious food marketing policy on effective attribute value of availability of low nutritious food. Since this policy only influences the availability of low nutritious food, it has no effect on other attributes and food categories.

Variable Type	Variable Name	Equation	Unit	Description
○	Effect of Marketing Policy on Attribute, Low Nutritious, Availability	Effect of Marketing Policy on Availability	Dimensionless	This is a variable that represents the effect of low nutritious food marketing policy on effective attribute value of availability of low nutritious food.
○	.Effect of Marketing Policy on Attribute, Low Nutritious, Price	1	Dimensionless	This is a variable that represents the effect of low nutritious food marketing policy on effective attribute value of availability of low nutritious food. Since this policy only influences the availability of low nutritious food, it has no effect on other attributes and food categories.
○	Effect of Marketing Policy on Availability	IF No Policy Switch=0 THEN 1+(STEP(-LN Marketing Policy Multiplier, Marketing Policy YEAR)-STEP(-LN Marketing Policy Multiplier, Marketing Policy YEAR+Marketing Policy Duration)) ELSE 1	Dimensionless	This is a variable that represents the effect of low nutritious food marketing policy on effective attribute value of availability of low nutritious food.
○	Effect of Price Policy on Attribute, High Nutritious, Taste	0	Dimensionless	This is a variable that represents the effect of low nutritious food price policy on effective attribute value of price. Since this policy only influences the price of low nutritious food, it has no effect on other attributes and food categories
○	Effect of Price Policy on Attribute, High Nutritious, Availability	0	Dimensionless	This is a variable that represents the effect of low nutritious food price policy on effective attribute value of price. Since this policy only influences the price of low nutritious food, it has no effect on other attributes and food categories
○	Effect of Price Policy on Attribute, High Nutritious, Price	0	Dimensionless	This is a variable that represents the effect of low nutritious food price policy on effective attribute value of price. Since this policy only influences the price of low nutritious food, it has no effect on other attributes and food categories
○	Effect of Price Policy on Attribute, Low Nutritious, Taste	0	Dimensionless	This is a variable that represents the effect of low nutritious food price policy on effective attribute value of price. Since this policy only influences the price of low nutritious food, it has no effect on other attributes and food categories
○	Effect of Price Policy on Attribute, Low Nutritious, Availability	0	Dimensionless	This is a variable that represents the effect of low nutritious food price policy on effective attribute value of price.

Variable Type	Variable Name	Equation	Unit	Description
				Since this policy only influences the price of low nutritious food, it has no effect on other attributes and food categories
	Effect of Price Policy on Attribute, Low Nutritious, Price	Effect of LN Food Price Policy		This is a variable that represents the effect of low nutritious food price policy on effective attribute value of price.
	Effective Attribute, Category, Attribute	Initial Attribute*Effect of Capabilities*Effect of Marketing Policy on Attribute+Effect of Price Policy on Attribute	Dimensionless	This variable calculates the rates at which the attribute utilities grow depending on the investment in capabilities of each food category and each attribute investments.
	Food Policy YEAR	2022	Years	This parameter indicates the year when the policies related to food environment starts.
	increase in capabilities, Category, Attribute	Relative Budget to Attributes*Productivity of Investment*1	Per Year	This flow calculates the rate at which capabilities increase. It is determined by investments on the capabilities of each food attribute of each food category
	Indicated Attribute Budget Share, Category, Attribute	Desired Attribute Budget/SUM(Desired Attribute Budget, Category, *)	Dimensionless	This is a variable that represents the goal for the budget share to be allocated to improvement of attribute-related capabilities of firms. The equation calculates the budget share for each attribute of the food category.
	Indicated Category Budget Share, Category	Desired Budget to Category/SUM(Desired Budget to Category)	Dimensionless	This is a variable that represents the goal for the budget share to be allocated to food category. The equation calculates the budget share for each attribute of the food category.
	Initial Attribute, High Nutritious, Taste	0.8	Dimensionless	This is a constant that represents the initial values of food category attributes (Struben et al., 2014). It has the assumption that low nutritious food are more available, cheaper and tastier than the high nutritious food initially.
	Initial Attribute, High Nutritious, Availability	1	Dimensionless	This is a constant that represents the initial values of food category attributes (Struben et al., 2014). It has the assumption that low nutritious food is more available, cheaper and tastier than the high nutritious food initially.
	Initial Attribute, High Nutritious, Price	1	Dimensionless	This is a constant that represents the initial values of food category attributes (Struben et al., 2014). It has the assumption that low nutritious food is more available, cheaper, and tastier than the high nutritious food initially.
	Initial Attribute, Low Nutritious, Taste	1.2	Dimensionless	This is a constant that represents the initial values of food category attributes (Struben

Variable Type	Variable Name	Equation	Unit	Description
				et al., 2014). It has the assumption that low nutritious food is more available, cheaper, and tastier than the high nutritious food initially.
○	Initial Attribute, Low Nutritious, Availability	1.2	Dimensionless	This is a constant that represents the initial values of food category attributes (Struben et al., 2014). It has the assumption that low nutritious food is more available, cheaper, and tastier than the high nutritious food initially.
○	Initial Attribute, Low Nutritious, Price	0.8	Dimensionless	This is a constant that represents the initial values of food category attributes (Struben et al., 2014). It has the assumption that low nutritious food is more available, cheaper and tastier than the high nutritious food initially.
○	Learning Exponent, Taste	0.3	Dimensionless	This is a constant that represents the learning curve exponent (Struben et al., 2014).
○	Learning Exponent, Availability	0.3	Dimensionless	This is a constant that represents the learning curve exponent (Struben et al., 2014).
○	Learning Exponent, Price	-0.3	Dimensionless	This is a constant that represents the learning curve exponent (Struben et al., 2014).
○	LN Food Price for Food Price Policy	HISTORY(Perceived LN Food Price, Food Policy YEAR)	NOK/Kilocalories	This is a variable that represents the price of low nutritious food to calculate its the policy price. The equation calculates the value of low nutrition food price in in the policy year.
○	LN Food Price INIT	Initial Attribute, Low Nutritious, Price*Reference Price	NOK/Kilocalories	This is a constant that represents the initial value of low nutritious food price.
○	LN Food Price Policy Multiplier	0.10	Dimensionless	This is a constant that represents the magnitude of the policy as an aggregate term that includes political support, commitment of the policy makers, allocation of budget and etc.
○	LN Marketing Policy Multiplier	0.10	Dimensionless	This is a constant that represents the magnitude of the policy as an aggregate term that includes political support, commitment of the policy makers, allocation of budget and etc.
○	Marketing Policy Duration	5	Years	This is a constant that represents how long the policy will be effective.
○	Marketing Policy YEAR	2022	Years	This parameter indicates the year when the marketing policy starts.

Variable Type	Variable Name	Equation	Unit	Description
○	People	1000	People	This is a constant that represents the number of people engaging in the market (Struben et al., 2014).
▭	Perceived LN Food Price	SMTH1(Category Price, Low Nutritious, Time to Perceive Price, Initial Attribute, Low Nutritious, Price*Reference Price)	NOK/Kilocalories	This is a stock that represents the low nutritious food price that is perceived by the suppliers. It is updated by the new information in the market about the low nutritious food category. This update occurs through a first order information delay based on the low nutritious food price level which is set in the market It is defined by a stock because information about price level of food can accumulate within the time horizon of the model. Therefore, it is described by an integral equation.
○	Price Policy Duration	5	Years	This is a constant that represents how long the policy will be effective.
○	Productivity of Investment	0.125	Dimensionless/year	This parameter indicates the assumed productivity that defines the increase rate in capabilities (Struben et al., 2014).
○	Reference Price	1	NOK/Kilocalories	This is a constant that represents the reference or initial value of price of food for both categories per kilo calories (Struben et al., 2014).
○	Relative Budget to Attributes, Category, Attribute	Budget to Attributes/Normal Budget to Attributes	Dimensionless	This variable represents the relative values of the budget for attributes compared to a normal budget for attributes.
○	Revenue	SUM(Category Revenues)	NOK/Days	This is a variable that represents the total revenue generated from the sales. The equation sums all the revenues from each food categories.
○	Sales	People*Sales per Person per Day	Kilocalories/Days	This is a variable that represents the total sales per day based on sales per person.
○	Sales per Person per Day	Portion Size*Servings per Day	Kilocalories/(Days *People)	This is a variable that represents the sales per kcal per day.
○	Time to Adjust Budget	1	Years	This is a constant that represents the time it takes to adjust the budget.
○	Time to Perceive Price	1	Years	This is a constant that represents the time it takes to perceive the price in the market.

Variable Type	Variable Name	Equation	Unit	Description
Other Calculations				
○	Desired Category Market Share, High Nutritious	1-Desired LN Market Share	Dimensionless	This is a constant that represents the desired category market share of the food category. The equation indicates that the remaining desired share after the share of low nutritious food determines the share of high nutritious food.
○	Desired Category Market Share, Low Nutritious	Desired LN Market Share	Dimensionless	This is a constant that represents the desired category market share of the food category. The equation indicates that the remaining desired share after the share of low nutritious food determines the share of high nutritious food.
○	Desired Consumption per Day	Desired consumption per meal*Servings per Day	Kilocalories/(Days *People)	This is a variable that represents the desired consumption per meal per day.
○	Desired consumption per meal	SUM(Desired Serving Size by Category)	Kilocalories/serving	This is a variable that represents the desired total consumption per serving.
○	Desired LN Market Share	0.25	Dimensionless	This is a constant that represents the initial desired market share for low nutritious food category.
○	Desired Serving Size by Category, Category	Desired Category Market Share*Portion Size INIT*Caloric Density	Kilocalories/serving	This is a variable that represents the desired serving size per serving per food category.
○	Familiarity HN INIT	0.6	Dimensionless	This is a constant that represents the initial value of familiarity of consumers with high nutritious food category.
○	Familiarity LN INIT	0.9	Dimensionless	This is a constant that represents the initial value of familiarity of consumers with low nutritious food category.
○	Familiarity with Category INIT, High Nutritious	Familiarity HN INIT	Dimensionless	This is a constant that represents the initial value of familiarity of consumers with high nutritious food category.
○	Familiarity with Category INIT, Low Nutritious	Familiarity LN INIT	Dimensionless	This is a constant that represents the initial value of familiarity of consumers with low nutritious food category.
○	HN Food Price Premium	MAX(Effective Attribute, High Nutritious, Price-Effective Attribute, Low Nutritious, Price, 0)*Reference Price	NOK/Kilocalories	This variable calculates the difference between high and low nutritious food categories. It is used to formulate the food price policy.
○	HN Food Price Premium for Price Policy	HISTORY(SMTH1(HN Food Price Premium, Time to Perceive Price, HN Food Price Premium INIT), Food Policy YEAR)	NOK/Kilocalories	This variable tracks the difference between high and low nutritious food categories at the moment when food price policy is

Variable Type	Variable Name	Equation	Unit	Description
				introduced. It is used to formulate the food price policy.
○	HN Food Price Premium INIT	MAX(Initial Attribute, High Nutritious, Price-Initial Attribute, Low Nutritious, Price, 0)*Reference Price	NOK/Kilocalories	This variable represents the initial difference between high and low nutritious food categories. It was used to formulate food price policy.
○	Marginal Attribute Utility from Budget to Category, Category, Attribute	Attribute Elasticity, Attribute*Initial Attribute*Effect of Marketing Policy on Attribute*Learning Exponent, Attribute*(Capabilities/Capabilities INIT)^(Learning Exponent, Attribute-1)*Productivity of Investment*1/Normal Budget to Attributes*Attribute Budget Share	Days/(NOK*Years)	This variable represents a measure of return in terms of utility per food attribute. It is calculated as a partial derivative.
○	Marginal Benefit of Budget to Attribute, Category, Attribute	Sales* (Category Market Share, Category*(1-Category Market Share, Category)*"Category Utility from Non-Nutritional Attributes", Category*Attribute Elasticity, Attribute*Initial Attribute*Effect of Marketing Policy on Attribute*Learning Exponent, Attribute*(Capabilities/Capabilities INIT)^(Learning Exponent, Attribute-1)*Productivity of Investment*1/Normal Budget to Attributes*Category Utility from Nutritional quality, Category^Relative Importance of Nutritional quality*(1-Relative Importance of Nutritional quality)*"Category Utility from Non-Nutritional Attributes", Category^(-Relative Importance of Nutritional quality)*Category Price, Category + Initial Attribute, Category, Price*Learning Exponent, Price*(Capabilities, Category, Price/Capabilities INIT, Category, Price)^(Learning Exponent, Price-1)*Productivity of Investment*1/Normal Budget to Attributes, Category, Price*Category Market Share, Category)	Dimensionless	This variable represents a measure of return to extra unit of budget spent per food attribute. It is calculated as a partial derivative.
○	Marginal Benefit of Budget to Category, Category	Sales* (Category Market Share*(1-Category Market Share)*"Category Utility from Non-Nutritional Attributes"*SUM(Marginal Attribute Utility from Budget to Category, Category, *)*Category Utility from Nutritional quality, Category^Relative Importance of Nutritional quality*(1-Relative Importance of Nutritional quality)*"Category Utility from Non-Nutritional Attributes", Category^(-Relative Importance of Nutritional quality)*Category Price + Initial Attribute, Category, Price*Learning Exponent, Price*(Capabilities, Category, Price/Capabilities INIT, Category, Price)^(Learning Exponent, Price-1)*Productivity of Investment*1/Normal Budget	Dimensionless	This variable represents a measure of return to extra unit of budget spent per food category. It is calculated as a partial derivative.

Variable Type	Variable Name	Equation	Unit	Description
		to Attributes, Category, Price*Category Market Share, Category)		
	Normal Budget to Attributes, Category, Attribute	INIT(Revenue)*Attribute Budget Share INIT	NOK/Days	This is a constant that represents the initial value of budget share allocated to improvement of attribute-related capabilities.
Physical Activity Environment				
Adolescents Engaged in OPA				
	Adolescents in Organized PA, Age 11 to 13, Male	Population Age 11 to 13, Male*Fraction of Adolescents engaged in PA, Age 11 to 13, Male*(1-Weight of Built Environment, Age 11 to 13, Male)	People	This variable calculates the number of male younger adolescents engaged in organized PA.
	Adolescents in Organized , Age 11 to 13, Female	Population Age 11 to 13, Female*(1-Weight of Built Environment, Age 11 to 13, Female)*Fraction of Adolescents engaged in PA, Age 11 to 13, Female	People	This variable calculates the number of female younger adolescents engaged in organized PA.
	Adolescents in Organized PA, Age 14 to 15, Male	Population Age 14 to 15, Male*Fraction of Adolescents engaged in PA, Age 14 to 15, Male*(1-Weight of Built Environment, Age 14 to 15, Male)	People	This variable calculates the number of male older adolescents engaged in organized PA.
	Adolescents in Organized PA, Age 14 to 15, Female	Population Age 11 to 13, Female*Fraction of Adolescents engaged in PA, Age 14 to 15, Female*(1-Weight of Built Environment, Age 14 to 15, Female)	People	This variable calculates the number of female older adolescents engaged in organized PA.
Built Environment				
	additions to BE	SMTH1(Replacement Level Additions to BE*Effect of Demand on Additions to BE, Time to Adjust BE)	Square Meters/Years	This inflow represents the rate at which BE becomes available, because of the demand of BE and the BE replacement level after the time it takes to adjust BE.
	Adolescents Fraction in Population	0.1	Dimensionless	This parameter indicates the percentage of the adolescent population.
	Adolescents Total	SUM(Population Age 11 to 13)+SUM(Population Age 14 to 15)	People	This variable represents the total adolescent population.
	Adolescents Using BE, Gender	Population Age 11 to 13*Fraction of Adolescents engaged in PA, Age 11 to 13, Gender*Weight of Built Environment, Age 11 to 13, Gender+ Population Age 14 to 15*Fraction of Adolescents engaged in PA, Age 14 to 15, Gender*Weight of Built Environment, Age 14 to 15, Gender	People	This variable calculates the number of adolescents engaged in PA using Built Environment. It is arrayed by gender.
	BE Density per Thousand Population	Built Environment/Population Total	Meters^2/People	This variable indicates the amount of BE per person in the population.

Variable Type	Variable Name	Equation	Unit	Description
	BE Density per Thousand Population Normal	0.7	Meters^2/People	This parameter indicates the reference value for the proportion of BE available per person.
	BE depreciation rate	Built Environment/BE Lifetime	Square Meters/Years	This flow represents the rate at which the BE depreciates over time, and it is formulated as a first-order exponential decay over the specified BE lifetime.
	BE Lifetime	40	Years	This parameter indicates the time in which the built environment decreases its value (Huang et al., 2013).
	BE Usage Rate per Adolescent	3*52	Hours/Year/Person	This parameter represents the rate at which adolescents use Built Environment.
	Built Environment(t)	Built Environment(t - dt) + (additions to BE - BE depreciation rate) * dt	Square Meters	This is a stock variable that calculates the physical assets related to the available built environment for both recreational and transport physical activity (parks, sidewalks, bicycle paths, etc.). Built environment accumulate over time, and it is calculated by the difference between the additions and reductions in BE. This stock increases as there is more investment allocated in these assets and it decreases due to depreciation. Built environment represent a part of the PA supply available.
	Built Environment INIT	Population Total*(BE Density per Thousand Population Normal*Fraction of BE Density Normal for BE INIT)	Square Meters	The initial value of the Built Environment stock.
	Effect of Demand on Additions to BE	Perceived Demand for BE/Normal Demand for BE*SWITCH Demand Feedback BE+1-SWITCH Demand Feedback BE	Dimensionless	This effect variable indicates the relationship between what is the expected demand versus a baseline demand on additions to BE.
	Effect of Willingness on Fraction of Adolescents in PA from BE, Age Band, Gender	GRAPH(Willingness to engage in PA/Fraction of Adolescents in PA Indicated by BE) Points: (0.000, 0.0000), (0.108333333333, 0.1483), (0.216666666667, 0.2763), (0.325, 0.3869), (0.433333333333, 0.4824), (0.541666666667, 0.5649), (0.650, 0.6361), (0.758333333333, 0.6976), (0.866666666667, 0.7508), (0.975, 0.7966), (1.08333333333, 0.8362), (1.19166666667, 0.8705), (1.300, 0.9000)	Dimensionless	This is a nonlinear function that indicates the relationship between willingness to engage in PA and the fraction of adolescents engage in PA indicated by BE. As the proportion of adolescents engaging in PA who are driven by willingness increases with respect to the engagement that is expected from them based on the currently available BE supply, the overall engagement in PA increases.
	Fraction of Adolescents in PA Indicated by BE	GRAPH(BE Density per Thousand Population/BE Density per Thousand Population Normal) Points: (0.000, 0.000), (0.200, 0.300), (0.400, 0.600), (0.600, 0.750), (0.800, 0.900), (1.000, 1.000)	Dimensionless	This is a nonlinear function that reflects how large the current density of BE is with respect the normal density of BE. The larger the current versus the normal, the larger will be the indicated (ought to be) fraction of adolescents in PA using the available BE.
	Fraction of BE Density Normal for BE INIT	1	Dimensionless	This parameter indicates the percentage of normal BE density for BE.

Variable Type	Variable Name	Equation	Unit	Description
○	Fraction of BE Density Normal for Demand	1	Dimensionless	This parameter indicates the percentage of normal BE density for demand.
○	Normal Demand for BE	Population Total*Adolescents Fraction in Population*Normal Fraction of Adolescents to Use BE*BE Usage Rate per Adolescent/Built Environment	Hours/(Meters^2 *Years)	This variable indicates the calculation of how many adolescents within the total population use BE. This ratio provides the demand (i.e. what is the needed BE for adolescents) being defined as how the need from BE from adolescents stands in relation to the current BE.
○	Normal Fraction of Adolescents to Use BE	0.3	Dimensionless	This parameter represents the normal Fraction of adolescents to use BE is the reference percentage of adolescents to use of BE usage of adolescents under normal conditions.
○	Perceived Demand for BE	SMTH1(SUM(Adolescents Using BE)*BE Usage Rate per Adolescent/Built Environment, Time to Perceive Demand for BE)	Hours/(Meters^2 *Years)	This variable indicates the general perception of the information about adolescents' usage of BE. It is calculated by a delayed function of the ratio between expected adolescents' usage of BE and the currently available BE, at a population level.
○	Population Total	Adolescents Total/Adolescents Fraction in Population	People	This parameter indicates the total population.
○	Replacement Level Additions to BE	BE depreciation rate	Meters^2/Years	This variable calculates the replenishment of the supply for BE based on the depreciation rate of the stock.
○	SWITCH Demand Feedback BE	1	Dimensionless	This is an operational parameter that activates the Built Environment demand feedback loop.
○	Time to Adjust BE	3	Years	This time constant indicates the time it takes to increase BE.
○	Time to Perceive Demand for BE	3	Years	This parameter indicates the time it takes to adjust BE additions based on its depreciation rate.
○	Weight of Built Environment, Age 11 to 13, Male	0.3	Dimensionless	This parameter indicates the percentage of male younger adolescents in PA that use BE.
○	Weight of Built Environment, Age 11 to 13, Female	0.3	Dimensionless	This parameter indicates the percentage of female younger adolescents in PA that use BE.
○	Weight of Built Environment, Age 14 to 15, Male	0.7	Dimensionless	This parameter indicates the percentage of male older adolescents in PA that use BE.
○	Weight of Built Environment, Age 14 to 15, Female	0.7	Dimensionless	This parameter indicates the percentage of female older adolescents in PA that use BE.
Organized Physical Activity				
	additions to Organized PA Supply, Age Band, Gender	MIN (SMTH1(Replacement Level Additions to Organized PA Supply*Effect of Demand on	people per person per year	This flow represents the rate at which organized PA supply becomes available, as

Variable Type	Variable Name	Equation	Unit	Description
		Additions to Organized PA Supply, Time to Adjust Organized PA Supply)+Exposure from Intervention 1, 1)		a result of the demand of organized PA and the organized PA replacement level.
	change in Fraction of Adolescents in PA from Willingness, Age Band, Gender	(Indicated Fraction of Adolescents in PA from Willingness-Willingness to engage in PA)/Time to Adjust Fraction of Adolescents in PA from Willingness	people per person per year	This flow represents the gap between the indicated fraction of adolescents in PA from willingness and the current fraction of adolescents in PA from willingness.
	Effect of Demand on Additions to Organized PA Supply, Age Band, Gender	Perceived Demand for Organized PA/Organized PA Supply*SWITCH Demand Feedback Organized PA+(1-SWITCH Demand Feedback Organized PA)	Dimensionless	This effect variable indicates the relationship between what is the expected demand versus a baseline demand on additions to Organized PA Supply.
	Effect of Willingness on Fraction of Adolescents in PA from Organized PA, Age Band, Gender	GRAPH(Willingness to engage in PA/Organized PA Supply) Points: (0.000, 0.0000), (0.108333333333, 0.1483), (0.216666666667, 0.2763), (0.325, 0.3869), (0.433333333333, 0.4824), (0.541666666667, 0.5649), (0.650, 0.6361), (0.758333333333, 0.6976), (0.866666666667, 0.7508), (0.975, 0.7966), (1.08333333333, 0.8362), (1.19166666667, 0.8705), (1.300, 0.9000)	Dimensionless	This is a nonlinear function that indicates the relationship between willingness to engage in PA and the fraction of adolescents engage in PA from Organized PA. As the proportion of adolescents engaging in PA who are driven by willingnes increases with respect to the engagement that is expected from them based on the currently available OPA supply, the overall engagement in PA increases.
	OPA Supply Intervention , Age Band, Gender	IF Food Environment.No Policy Switch=0 THEN STEP(OPA Supply Intervention Input 1, OPA Supply Intervention Year 1)-STEP(OPA Supply Intervention Input 1, OPA Supply Intervention Year 1+OPA Supply Intervention Duration 1) ELSE 0	Dimensionless	This is an operational variable that activates and deactivates the PA intervention that affects organized PA additions.
	Fraction for Normal Organized PA Reductions	0.025	Dimensionless	This parameter represents the normal percentage at which the organized PA activities decay over time.
	Fraction of Adolescents in PA Indicated by Social Norm, Age Band, Gender	SMTH1(Fraction of Adolescents engaged in PA, Time to Adjust Social Norm, Fraction of Adolescents in PA Indicated by Social Norm INIT)	Dimensionless	This variable represents the general perception of the information about the percentage of adolescent PA engagement determined by a PA social norm. It is defined by a first order information delay function of the fraction of adolescents engaged in PA and the fraction of adolescents engaged in PA determined by a PA social norm.
	Fraction of Adolescents in PA Indicated by Social Norm INIT	0.3	Dimensionless	This parameter indicates the initial fraction of adolescents engaged in PA indicated by the PA social norm.
	Indicated Fraction of Adolescents in PA from Willingness, Age Band, Gender	Fraction of Adolescents in PA Indicated by Social Norm*Weight of Social Norm+Propensity to Engage in PA*(1-Weight of Social Norm)	Dimensionless	This variable represents the indicated percentage of adolescents engaged in PA determined by willingness. This variable calculates the percentage of adolescents that participate in PA because they are willing to do so and not because they must exercise at schools, for example.

Variable Type	Variable Name	Equation	Unit	Description
○	OPA Supply Intervention Duration 1	5	Years	This parameter indicates the baseline PA intervention duration.
○	OPA Supply Intervention A11 to A13 1	OPA Supply Intervention A14 to A15 1	Dimensionless	This is an operational parameter that provides input to the of PA exposure policy for older adolescents. It is activated when the PA policy is activated.
○	OPA Supply Intervention A14 to A15 1	0.10	Dimensionless	This parameter indicates the baseline PA intervention magnitude.
○	OPA Supply Intervention Input 1, Age 11 to 13, Male	OPA Supply Intervention A11 to A13 1	Dimensionless	This is an operational parameter that provides input to the of PA exposure policy for younger adolescents. It is activated when the PA policy is activated.
○	OPA Supply Intervention Input 1, Age 11 to 13, Female	OPA Supply Intervention A11 to A13 1	Dimensionless	This is an operational parameter that provides input to the of PA exposure policy for younger adolescents. It is activated when the PA policy is activated.
○	OPA Supply Intervention Input 1, Age 14 to 15, Male	OPA Supply Intervention A14 to A15 1	Dimensionless	This is an operational parameter that provides input to the of PA exposure policy for older adolescents. It is activated when the PA policy is activated.
○	OPA Supply Intervention Input 1, Age 14 to 15, Female	OPA Supply Intervention A14 to A15 1	Dimensionless	This is an operational parameter that provides input to the of PA exposure policy for older adolescents. It is activated when the PA policy is activated.
○	OPA Supply Intervention Year 1	2022	Years	This parameter indicates the year at which the PA policy intervention starts.
▭	Organized PA Supply, Age Band, Gender(t)	Organized PA Supply, Age Band, Gender(t - dt) + (additions to Organized PA Supply, Age Band, Gender - reductions in Organized PA Supply, Age Band, Gender) * dt	Dimensionless	This is a stock variable that calculates the total resources available as organized PA (exercise equipment, human resources, competences, and activities) at each point in time. It is calculated by the integrated difference between the inflow additions to Organized PA and Reductions in Organized PA. The initial value of this stock is Organized PA supply INIT.
○	Organized PA Supply INIT, Age 11 to 13, Male	0.5	Dimensionless	Initial value of Organized PA supply stock for male adolescents aged 11 to 13
○	Organized PA Supply INIT, Age 11 to 13, Female	0.5	Dimensionless	Initial value of Organized PA supply stock for female adolescents aged 11 to 13
○	Organized PA Supply INIT, Age 14 to 15, Male	0.5	Dimensionless	Initial value of Organized PA supply stock for male adolescents aged 14 to 15
○	Organized PA Supply INIT, Age 14 to 15, Female	0.5	Dimensionless	Initial value of Organized PA supply stock for female adolescents aged 14 to 15
○	PA engagement %, Age Band, Gender	Fraction of Adolescents engaged in PA*100	Dimensionless	This variable converts the fraction of adolescents engaged in PA in percentage notation.

Variable Type	Variable Name	Equation	Unit	Description
	Perceived Demand for Organized PA, Age Band, Gender	SMTH1(Fraction of Adolescents engaged in PA*(1-Weight of Built Environment), Time to Perceive Demand for Organized PA)	Dimensionless	This variable indicates general perception of the information about the Organized PA which are after-school activities that mandatory in some countries. It is calculated by a first order information delay and it is segmented by age and gender.
	reductions in Organized PA Supply, Age Band, Gender	Organized PA Supply*Fraction for Normal Organized PA Reductions	people per person per year	This flow represents the reductions in the organized PA supply given a normal fraction of organized PA reductions.
	Replacement Level Additions to Organized PA Supply, Age Band, Gender	reductions in Organized PA Supply	people per person per year	This variable calculates the replenishment of the supply for OPA based on the depreciation rate of the stock.
	SWITCH Demand Feedback Organized PA	1	Dimensionless	This is an operational parameter that activates and deactivates the Organized PA demand feedback loop.
	Time to Adjust Fraction of Adolescents in PA from Willingness	3	Years	This parameter indicates the average time it takes to adjust gap between the indicated fraction of adolescents engaged in PA from Motivation and the current Fraction of adolescents in PA from Motivation.
	Time to Adjust Organized PA Supply	3	Years	This parameter indicates the average time it takes to adjust Organized PA supply.
	Time to Adjust Social Norm	5	Years	This parameter indicates the average time it takes to adjust the social norm regarding PA participation at a population level.
	Time to Adjust OPA Supply Intervention	2	Years	This parameter indicates the average time it takes to adjust Organized PA supply intervention.
	Time to Perceive Demand for Organized PA	3	Years	This parameter indicates the average time it takes to adjust gap between the indicated fraction of adolescents engaged in PA from Motivation and the current Fraction of adolescents in PA from Motivation.
	Weight of Social Norm	0.3	Dimensionless	This parameter indicates the weight of the PA social norm that determines the fraction of adolescents in PA indicated by the PA social norm.
	Willingness to engage in PA, Age Band, Gender(t)	Willingness to engage in PA, Age Band, Gender(t - dt) + (change in Fraction of Adolescents in PA from Willingness, Age Band, Gender) * dt	Dimensionless	This is a stock variable that calculates the portion of the adolescent population engaged in PA because they are willing to do so. This motivation determines the demand to use the available built environment and organized PA supply available. This concept is intangible, but it accumulates over time, and it changes according to the social norm related to PA at the societal level.

Variable Type	Variable Name	Equation	Unit	Description
Physical Activity Engagement				
	Fraction of Adolescents engaged in PA, Age Band, Gender	Organized PA Supply*Effect of Willingness on Fraction of Adolescents in PA from Organized PA*(1-Weight of Built Environment)+Fraction of Adolescents in PA Indicated by BE*Effect of Willingness on Fraction of Adolescents in PA from BE*Weight of Built Environment	Dimensionless	This variable represents the PA engagement, or the interaction between demand and supply. The two components are blended there, we add a weight of BE to experiment with the different role of BE for different population cohorts. This can also be considered as the probability of adolescents to engage in PA.
Propensity to Do Physical Activity				
	Exposure from PA Engagement, Age 11 to 13, Male	PA Engagement, Age 11 to 13, Male	Dimensionless	This variable calculates the percentage of male younger adolescents given a PA engagement.
	Exposure from PA Engagement, Age 11 to 13, Female	PA Engagement, Age 11 to 13, Female	Dimensionless	This variable calculates the percentage of female younger adolescents given a PA engagement.
	Exposure from PA Engagement, Age 14 to 15, Male	PA Engagement, Age 11 to 13, Male*Weight of PA Fraction A11 to A13 in Exposure for A14 to A15+PA Engagement, Age 14 to 15, Male*(1-Weight of PA Fraction A11 to A13 in Exposure for A14 to A15)	Dimensionless	This variable calculates the percentage of male older adolescent exposure to PA from younger adolescents increase the PA engagement of older adolescents.
	Exposure from PA Engagement, Age 14 to 15, Female	PA Engagement, Age 11 to 13, Female*Weight of PA Fraction A11 to A13 in Exposure for A14 to A15+PA Engagement, Age 14 to 15, Female*(1-Weight of PA Fraction A11 to A13 in Exposure for A14 to A15)	Dimensionless	This variable calculates the percentage of female older adolescent exposure to PA from younger adolescents increase the PA engagement of older adolescents.
	exposure to PA, Age Band, Gender	MIN(Exposure from PA Engagement, 1)	Per Year	This flow represents the exposure to PA which is what makes propensity increase and it is determined by PA engagement depending on the fraction of adolescents in PA and whether they are younger adolescents or older adolescents.
	forgetting rate, Age Band, Gender	Propensity to Engage in PA/Time to Forget exposure	Per Year	This flow represents the reduction on the propensity to engage in PA over time as the exposure to PA is not enough to maintain the propensity.
	PA Engagement, Age 11 to 13, Male	Average PA Fraction A11 to A13, Male	Dimensionless	This variable calculates the PA engagement of adolescents obtained by the average PA fraction in younger male adolescents.
	PA Engagement, Age 11 to 13, Female	Average PA Fraction A11 to A13, Female	Dimensionless	This variable calculates the PA engagement of adolescents obtained by the average PA fraction in younger female adolescents.
	PA Engagement, Age 14 to 15, Male	Average PA Fraction A14 to A15, Male	Dimensionless	This variable calculates the PA engagement of adolescents obtained by the average PA fraction in older male adolescents.

Variable Type	Variable Name	Equation	Unit	Description
	PA Engagement, Age 14 to 15, Female	Average PA Fraction A14 to A15, Female	Dimensionless	This variable calculates the PA engagement of adolescents obtained by the average PA fraction in older female adolescents.
	Propensity to Engage in PA, Age Band, Gender(t)	Propensity to Engage in PA, Age Band, Gender(t - dt) + (exposure to PA, Age Band, Gender - forgetting rate, Age Band, Gender) * dt	Dimensionless	This is a stock variable that calculates the likelihood that adolescents engage in PA based on the exposure to exercise they have. This stock can also be considered as awareness of PA benefits, a personal propensity to engage in PA. It is calculated by the integrated difference between continuous exposure to PA that allows to maintain this propensity, and its decay when this is forgotten over time, namely, if the propensity is not enough the person will be less inclined to engage in PA.
	Propensity to Engage in PA INIT, Age Band, Gender	0.5	Dimensionless	The initial value of the propensity to engage in PA stock.
	Time to Forget exposure	1	Years	This parameter indicates the time it takes for adolescents to forget their exposure to PA.
	Time to Adjust Exposure to PA	2	Years	This parameter indicates the time it takes for adolescents to adjust their exposure to PA.
	Weight of PA Fraction A11 to A13 in Exposure for A14 to A15	0.2	Dimensionless	This parameter indicates the percentage at which exposure to PA from younger adolescents increase the PA engagement of older adolescents.
Mental Wellbeing				
	Average PAL per gender per age group, Gender, Age Group	MEAN(Physical Activity level, *, Gender, Age Group)	Dimensionless	This variable indicates the average physical activity level segmented by gender and age group. It is calculated by the mean of PAL coming from the BMI and population module.
	average time to modify SE	1.2	Years	This constant indicates the time it takes to adjust the indicated self-esteem factor.
	change in PPOBI, Gender, Age Group	(indicated perceived POBI-Perceived pressure on body image)/time to change PPOBI	people per person per year	This flow represents the rate at which the perceived pressure on body image stock adjust itself based on the indicated PPOBI after the time it takes to change expected body image.
	change in mental health, Gender, Age Group	(indicated mental wellbeing-Mental Wellbeing)/time to adjust mental wellbeing	people per person per year	This flow represents the rate at which the mental wellbeing stock adjust itself based on the indicated mental wellbeing after the time it takes to adjust mental wellbeing.

Variable Type	Variable Name	Equation	Unit	Description
	change in sleep quality, Gender, Age Group	(indicated sleep quality-Sleep quality)/time to adjust sleep quality	people per person per year	This flow represents the rate at which the sleep quality stock adjust itself based on the indicated sleep quality after the time it takes to adjust sleep quality .
	"effect of PPOBI on self-esteem", Gender, Age Group	GRAPH(Perceived pressure on body image) Points: (0.000, 1.000), (0.200, 0.6703), (0.400, 0.4493), (0.600, 0.3012), (0.800, 0.2019), (1.000, 0.1353), (1.200, 0.09072), (1.400, 0.06081), (1.600, 0.04076), (1.800, 0.02732), (2.000, 0.01832)	Dimensionless	This nonlinear function indicates the effect of PPOBI on self-esteem. The function's input is PPOBI, and its shape shows an exponential decay. When POBI is zero or close to it, self-esteem is high. As POBI increases, self-esteem decreases. These two variables are inverse.
	gender difference, Male, Age 11	0.25	Dimensionless	This parameter indicates a differentiating factor separating male and female, where gender differences related to mental wellbeing response can be hypothesized based on qualitative data.
	gender difference, Male, Age 13	0.20	Dimensionless	This parameter indicates a differentiating factor separating male and female, where gender differences related to mental wellbeing response can be hypothesized based on qualitative data.
	gender difference, Male, Age 15	0.15	Dimensionless	This parameter indicates a differentiating factor separating male and female, where gender differences related to mental wellbeing response can be hypothesized based on qualitative data.
	gender difference, Female, Age 11	0.6	Dimensionless	This parameter indicates a differentiating factor separating male and female, where gender differences related to mental wellbeing response can be hypothesized based on qualitative data.
	gender difference, Female, Age 13	0.7	Dimensionless	This parameter indicates a differentiating factor separating male and female, where gender differences related to mental wellbeing response can be hypothesized based on qualitative data.
	gender difference, Female, Age 15	0.8	Dimensionless	This parameter indicates a differentiating factor separating male and female, where gender differences related to mental wellbeing response can be hypothesized based on qualitative data.
	indicated mental wellbeing, Gender, Age Group	(normal mental wellbeing/max mental wellbeing)*"indicated self-esteem"*1/(Perceived Psychosocial Stress)*(Sleep quality/Max sleep quality) * gender difference	Dimensionless	This variable represents the indicated mental wellbeing that defines the change in mental wellbeing stock. It is calculated by multiplying scaling factor obtained from the HBSC survey (mental wellbeing) by the indicated self-esteem variable interaction term. Then multiplied by the inverse of perceived stress, then multiplied by the normalized factor for sleep quality. Finally multiplied by the gender difference factor.

Variable Type	Variable Name	Equation	Unit	Description
○	"indicated self-esteem", Gender, Age Group	SMTH1("effect of PPOBI on self-esteem", average time to modify SE)	Dimensionless	This variable represents the indicated self-esteem. It is calculated by the delayed effect of PPOBI on self-esteem and adjusted by a delay time to modify self-esteem. This delay process is captured by the SMTH1 function that indicates a first order information delay adjustment.
○	indicated sleep quality, Gender, Age Group	GRAPH(Average_PAL_per_Gender_per_Age_Group*(Relative_Sleep_Easiness)/(Relative_Computer_Overuse)*1/Perceived_Psychosocial_Stress) Points: (0.000, 0.1000), (0.400, 0.1900), (0.800, 0.2800), (1.200, 0.3700), (1.600, 0.4600), (2.000, 0.5500), (2.400, 0.6400), (2.800, 0.7300), (3.200, 0.8200), (3.600, 0.9100), (4.000, 1.0000)	Dimensionless	This is a nonlinear function that calculates the indicated sleep quality. In this equation, the average PAL is multiplying the scaling factor from sleep easiness given that their relationship is positive, while the relationship between indicated sleep quality and computer overuse is negative, therefore it is dividing in this calculation. Indicated sleep quality (shape): this shape is linear since the outcome of the equation has a monotonically positive relationship with indicated sleep quality.
○	indicated Stress, Gender, Age Group	GRAPH(Perceived pressure on body image * (school pressure/max school pressure) * ("weight-related bullying"/max bullying) / (normal Not Nervous/max Not Nervous)) Points: (0.0500, 0.1060), (0.0650, 0.1162), (0.0800, 0.1427), (0.0950, 0.2073), (0.1100, 0.3420), (0.1250, 0.5500), (0.1400, 0.7580), (0.1550, 0.8927), (0.1700, 0.9573), (0.1850, 0.9838), (0.2000, 0.9940)	Dimensionless	This a nonlinear function calculating the indicated perceived stress. Indicated Stress (equation): POBI multiplied by three scaling factors that are exogenous parameters influencing indicated stress. In this case, school pressure and weight-related bullying have positive relationships with the resulting indicated stress, meanwhile, feeling Not Nervous has a negative relationship therefore, it is dividing the rest of the equation's components. Indicated Stress (effect's shape): this relationship exhibits a sigmoidal shape. This means that the initial part of the curve is almost exponential whereas the last part of the curve is almost logarithmic. The reasoning behind this shape is that when there is a POBI in the beginning it contributes substantially to the resulting stress, but there comes a point where the marginal POBI no longer leads to high increments on stress but rather small or almost negligible increases.
○	max bullying	5	Dimensionless	This parameter indicates the maximum value defined by the HBSC survey response scales. In this scale, 5 means that the

Variable Type	Variable Name	Equation	Unit	Description
				respondents were bullied several times a week.
	max computer overuse	9	Dimensionless	This parameter indicates the maximum value defined by the HBSC survey response scales. In this scale, 9 means that the respondents used computers about 7 or more hours per day.
	max mental wellbeing	5	Dimensionless	This parameter indicates the maximum value defined by the HBSC survey response scales. In this scale, 5 means that the respondents felt mentally well about every day.
	max school pressure	4	Dimensionless	This parameter indicates the maximum value defined by the HBSC survey response scales. In this scale, 4 means that the respondents were pressured by schoolwork a lot.
	max sleep easiness	5	Dimensionless	This parameter indicates the maximum value defined by the HBSC survey response scales. In this scale, 5 means that the respondents had easiness sleeping about every day.
	Max sleep quality	2	Dimensionless	This parameter indicates the reference value for sleep quality.
	max Not Nervous	5	Dimensionless	This parameter indicates the maximum value defined by the HBSC survey response scales. In this scale, 5 means that the respondents felt not nervous about every day.
	Mental Wellbeing, Gender, Age Group(t)	Mental Wellbeing, Gender, Age Group(t - dt) + (change in mental wellbeing, Gender, Age Group) * dt	Dimensionless	This is a stock variable that calculates the accumulation of mental wellbeing at each point in time based on its initial value plus the change in mental wellbeing rate. This stock encompasses the general emotional state of adolescents, includes disorders such as anxiety and depression. The relationship of this stock with increased BMI is modeled through emotional eating via EI and motivation to do PA via EE. Mental Wellbeing in adolescence is associated with greater amounts of fat gain and abdominal adiposity in adolescence (Aparicio et al., 2015)
	normal mental wellbeing, Male, Age 11	4.159	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
	normal mental wellbeing, Male, Age 13	4.313	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses

Variable Type	Variable Name	Equation	Unit	Description
				based on the survey scales. This parameter is arrayed by gender and age group.
○	normal mental wellbeing, Male, Age 15	4.304	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	normal mental wellbeing, Female, Age 11	3.736	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	normal mental wellbeing, Female, Age 13	3.798	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	normal mental wellbeing, Female, Age 15	3.603	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	normal Not Nervous, Male, Age 11	4.188	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	normal Not Nervous, Male, Age 13	4.157	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	normal Not Nervous, Male, Age 15	4.260	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	normal Not Nervous, Female, Age 11	3.951	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	normal Not Nervous, Female, Age 13	3.955	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	normal Not Nervous, Female, Age 15	3.988	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
▭	Perceived pressure on body image, Gender, Age Group(t)	Perceived pressure on body image, Gender, Age Group(t - dt) + (change in expected body image, Gender, Age Group) * dt	Dimensionless	This is a stock variable that calculates the accumulation of perceived pressure on body image at each point in time based on its initial value plus the change in expected body image rate. Note: the difference (gap) between current and ideal body weight creates pressure on

Variable Type	Variable Name	Equation	Unit	Description
				body image which is a perception, and it takes time for the person to become pressured.
▭	Perceived Psychosocial Stress, Gender, Age Group(t)	Perceived Psychosocial Stress, Gender, Age Group(t - dt) + (stress perception change, Gender, Age Group) * dt	Dimensionless	This is a stock variable that calculates the accumulation of perceived psychosocial stress at each point in time based on its initial value plus the change in stress perception rate.
○	Normal Sleep Easiness, Male, Age 11	3.910	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	Normal Sleep Easiness, Male, Age 13	4.158	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	Normal Sleep Easiness, Male, Age 15	4.201	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	Normal Sleep Easiness, Female, Age 11	3.650	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	Normal Sleep Easiness, Female, Age 13	4.008	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	Normal Sleep Easiness, Female, Age 15	3.923	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	Relative Sleep Easiness, Gender, Age Group	Normal_Sleep_Easiness/Max_Sleep_Easiness	Dimensionless	This is the normalized value for the sleep easiness.
○	Relative Sleep Quality, Gender, Age Group	Sleep_Quality/Max_Sleep_Quality	Dimensionless	This is the normalized value for the Sleep Quality.
○	Relative Sleep Quality, Gender, Age Group	Normal_Computer_Overuse/Max_Computer_Overuse	Dimensionless	This is the normalized value for the Computer Overuse.
▭	Sleep quality, Gender, Age Group(t)	Sleep quality, Gender, Age Group(t - dt) + (change in sleep quality, Gender, Age Group) * dt	Dimensionless	This is a stock variable that calculates the accumulation of sleep quality at each point in time based on its initial value plus the change in sleep quality rate. The association between BMI and depressive symptoms was mediated by sleep problems (EBRB). (Chang et al. 2017) Lack of sleep increases the risk of depression (Faulkner et al., 2020)

Variable Type	Variable Name	Equation	Unit	Description
◯	stress level ADJ time	1.5	year	This constant represents the time it takes to adjust psychological stress.
◯	stress perception change, Gender, Age Group	(indicated Stress-Perceived Psychosocial Stress)/stress level ADJ time	people per person per year	This flow represents the rate at which the perceived psychological stress stock adjust itself based on the indicated stress after the time it takes to change expected body image.
◯	time to adjust mental wellbeing	1.5	Years	This constant represents the time it takes to adjust mental wellbeing.
◯	time to adjust sleep quality	1	Years	This constant represents the time it takes to adjust sleep quality.
◯	time to change PPOBI	1	years	This constant represents the time it takes to change the perceived pressure on body image.
◯	Binge Eating (BE) Multiplier, Gender, Age Group	(Mental_Wellbeing_Difference)*Fraction_of_MW_on_BE	Dimensionless	This multiplier indicates the effect of stress, and mental wellbeing have on the binge eating behavior and subsequent overconsumption. In the literature, many studies suggest that decrease in mental wellbeing leads to binge eating (Turton et al., 2017; Pizzi & Vroman, 2013; Neumark-Sztainer et al., 2006; Lewis-Smith et al., 2020; Stice et al., 2002).
◯	Low Appetite (LA) Multiplier	(Mental_Wellbeing_Difference)*Fraction_of_MW_on_LA	Dimensionless	This multiplier indicates the effect of stress, and mental wellbeing have on the loss appetite, hence low appetite and subsequent underconsumption. In the literature, some studies suggest that decrease in mental wellbeing leads to unhealthy weight loss diets (Neumark-Sztainer et al., 2006).
◯	Mental Wellbeing Difference	(1-"Mental_Wellbeing_(MW)"-No_Behavior_Change)	Dimensionless	This equation calculates the mental wellbeing that might lead to change in eating behavior. Hence, the equation reflects both possibilities namely change in behavior or no change in behavior.
◯	No Behavior Change	0.1	Dimensionless	This parameter indicates the fraction of mental wellbeing does not lead to any change in behavior.
◯	Fraction of MW on LA	(1-Fraction_of_MW_on_BE)	Dimensionless	This fraction indicates the percentage of the mental wellbeing leads to low appetite behavior.
◯	Fraction of MW on BE	0.8	Dimensionless	This fraction indicates the percentage of the mental wellbeing leads to binge eating behavior.
◯	computer overuse, Male, Age 11	3.094	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.

Variable Type	Variable Name	Equation	Unit	Description
○	computer overuse, Male, Age 13	3.805	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	computer overuse, Male, Age 15	4.044	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	computer overuse, Female, Age 11	2.262	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	computer overuse, Female, Age 13	2.381	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	computer overuse, Female, Age 15	2.322	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	Social Norm on Body Image, Male, Age 11	1.10	Dimensionless	This parameter indicates the cultural factor related to a specific ideal body weight. This is a coefficient in the weight bias formulation which can vary according to different contexts. It is arrayed by gender and age group.
○	Social Norm on Body Image, Male, Age 13	1.20	Dimensionless	This parameter indicates the cultural factor related to a specific ideal body weight. This is a coefficient in the weight bias formulation which can vary according to different contexts. It is arrayed by gender and age group.
○	Social Norm on Body Image, Male, Age 15	1.30	Dimensionless	This parameter indicates the cultural factor related to a specific ideal body weight. This is a coefficient in the weight bias formulation which can vary according to different contexts. It is arrayed by gender and age group.
○	Social Norm on Body Image, Female, Age 11	1.10	Dimensionless	This parameter indicates the cultural factor related to a specific ideal body weight. This is a coefficient in the weight bias formulation which can vary according to different contexts. It is arrayed by gender and age group.
○	Social Norm on Body Image, Female, Age 13	1.30	Dimensionless	This parameter indicates the cultural factor related to a specific ideal body weight. This is a coefficient in the weight bias formulation which can vary according to different contexts. It is arrayed by gender and age group.

Variable Type	Variable Name	Equation	Unit	Description
○	Social Norm on Body Image, Female, Age 15	1.31	Dimensionless	This parameter indicates the cultural factor related to a specific ideal body weight. This is a coefficient in the weight bias formulation which can vary according to different contexts. It is arrayed by gender and age group.
○	school pressure, Male, Age 11	2.097	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	school pressure, Male, Age 13	2.160	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	school pressure, Male, Age 15	2.478	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	school pressure, Female, Age 11	2.002	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	school pressure, Female, Age 13	2.263	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	school pressure, Female, Age 15	2.650	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	Normal Bullying, Male, Age 11	1.739	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group. The association between BMI (body weight) and depressive symptoms (mental health) is significantly mediated by peer victimization (exogenous stressor) (Chang et al. 2017)
○	Normal Bullying, Male, Age 13	1.571	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group. The association between BMI (body weight) and depressive symptoms (mental health) is significantly mediated by peer victimization (exogenous stressor) (Chang et al. 2017)
○	Normal Bullying , Male, Age 15	1.360	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses

Variable Type	Variable Name	Equation	Unit	Description
				based on the survey scales. This parameter is arrayed by gender and age group. The association between BMI (body weight) and depressive symptoms (mental health) is significantly mediated by peer victimization (exogenous stressor) (Chang et al. 2017)
○	Normal Bullying , Female, Age 11	1.737	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group. The association between BMI (body weight) and depressive symptoms (mental health) is significantly mediated by peer victimization (exogenous stressor) (Chang et al. 2017)
○	Normal Bullying , Female, Age 13	1.372	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group. The association between BMI (body weight) and depressive symptoms (mental health) is significantly mediated by peer victimization (exogenous stressor) (Chang et al. 2017)
○	Normal Bullying , Female, Age 15	1.307	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group. The association between BMI (body weight) and depressive symptoms (mental health) is significantly mediated by peer victimization (exogenous stressor) (Chang et al. 2017)
○	motivation to do PA multiplier, Gender, Age Group	GRAPH(Mental Wellbeing/Perceived Psychosocial Stress) Points: (0.000, 0.000), (0.150, 0.06121), (0.300, 0.1289), (0.450, 0.2036), (0.600, 0.2862), (0.750, 0.3775), (0.900, 0.4785), (1.050, 0.590), (1.200, 0.7132), (1.350, 0.8495), (1.500, 1.000)	Dimensionless	This nonlinear function calculates the effect that stress, and mental wellbeing have on the motivation to do PA behavior and subsequent increase/decrease of PAL (Stults-Kolehmainen et al., 2014). Its equation is determined by the mean of a ratio between mental wellbeing and stress which reflects the balance between these opposing elements. The reason why we are using a MEAN function is because we are averaging these ratios across both genders and all age groups. This means that there is one ratio for motivation to do PA for everyone instead of having one for each dimension (this can be changed if needed).

Variable Type	Variable Name	Equation	Unit	Description
				Motivation to do PA shape: this shape is an exponential growth function since when the mean between mental wellbeing and stress are zero or close, the motivation to do PA multiplier is low and when the mean increases the emotional eating multiplier increases (Delgado-Floody et al., 2020, Sander et al., 2018, Pizzi & Vroman, 2013).
○	average body weight by gender & age group, Male, Age 11	(Body Weight BW, Normal Weight, Male, Age 11*Normal weight Fraction by Age, Male, Age 11)+(Body Weight BW, Overweight, Male, Age 11*Overweight Fraction by Age, Male, Age 11)+(Body Weight BW, Obese, Male, Age 11*Obese Fraction by Age, Male, Age 11)	kg	This variable indicates the average values of body weight of each population subgroup coming from the BMI and population module. It is arrayed by gender and age group.
○	average body weight by gender & age group, Male, Age 13	(Body Weight BW, Normal Weight, Male, Age 13*Normal weight Fraction by Age, Male, Age 13)+(Body Weight BW, Overweight, Male, Age 13*Overweight Fraction by Age, Male, Age 13)+(Body Weight BW, Obese, Male, Age 13*Obese Fraction by Age, Male, Age 13)	kg	This variable indicates the average values of body weight of each population subgroup coming from the BMI and population module. It is arrayed by gender and age group.
○	average body weight by gender & age group, Male, Age 15	(Body Weight BW, Normal Weight, Male, Age 15*Normal weight Fraction by Age, Male, Age 15)+(Body Weight BW, Overweight, Male, Age 15*Overweight Fraction by Age, Male, Age 15)+(Body Weight BW, Obese, Male, Age 15*Obese Fraction by Age, Male, Age 15)	kg	This variable indicates the average values of body weight of each population subgroup coming from the BMI and population module. It is arrayed by gender and age group.
○	average body weight by gender & age group, Female, Age 11	(Body Weight BW, Normal Weight, Female, Age 11*Normal weight Fraction by Age, Female, Age 11)+(Body Weight BW, Overweight, Female, Age 11*Overweight Fraction by Age, Female, Age 11)+(Body Weight BW, Obese, Female, Age 11*Obese Fraction by Age, Female, Age 11)	kg	This variable indicates the average values of body weight of each population subgroup coming from the BMI and population module. It is arrayed by gender and age group.
○	average body weight by gender & age group, Female, Age 13	(Body Weight BW, Normal Weight, Female, Age 13*Normal weight Fraction by Age, Female, Age 13)+(Body Weight BW, Overweight, Female, Age 13*Overweight Fraction by Age, Female, Age 13)+(Body Weight BW, Obese, Female, Age 13*Obese Fraction by Age, Female, Age 13)	kg	This variable indicates the average values of body weight of each population subgroup coming from the BMI and population module. It is arrayed by gender and age group.
○	average body weight by gender & age group, Female, Age 15	(Body Weight BW, Normal Weight, Female, Age 15*Normal weight Fraction by Age, Female, Age 15)+(Body Weight BW, Overweight, Female, Age 15*Overweight Fraction by Age, Female, Age 15)+(Body Weight BW, Obese, Female, Age 15*Obese Fraction by Age, Female, Age 15)	kg	This variable indicates the average values of body weight of each population subgroup coming from the BMI and population module. It is arrayed by gender and age group.
○	average ideal weight, Male, Age 11	29	kg	This parameter represents the perceived ideal body weight according to specific gender and age group.

Variable Type	Variable Name	Equation	Unit	Description
◯	average ideal weight, Male, Age 13	36	kg	This parameter represents the perceived ideal body weight according to specific gender and age group.
◯	average ideal weight, Male, Age 15	45	kg	This parameter represents the perceived ideal body weight according to specific gender and age group.
◯	average ideal weight, Female, Age 11	28	kg	This parameter represents the perceived ideal body weight according to specific gender and age group.
◯	average ideal weight, Female, Age 13	34	kg	This parameter represents the perceived ideal body weight according to specific gender and age group.
◯	average ideal weight, Female, Age 15	39	kg	This parameter represents the perceived ideal body weight according to specific gender and age group.
◯	indicated perceived POBI, Gender, Age Group	GRAPH((weight bias/average body weight by gender & age group)*(normal feel fat/max feel fat)) Points: (0.1000, 0.2000), (0.1200, 0.2490), (0.1400, 0.3031), (0.1600, 0.3629), (0.1800, 0.4290), (0.2000, 0.5020), (0.2200, 0.5828), (0.2400, 0.6720), (0.2600, 0.7706), (0.2800, 0.8796), (0.3000, 1.0000)	Dimensionless	Indicated perceived POBI (equation): this variable calculates the ratio between weight bias and the average body weight. It shows how much of a percentage weight bias makes when compared with the average body weight. Then this is multiplied by a scaling factor which takes a maximum value of the survey scale and compares it with a typical level of feel fat according to HBSC survey (this is a ratio a percentage that represents how normal is this feeling). This gives a gap representing how deviated is the representative individual's current weight from the ideal body weight. Indicated perceived POBI (shape): when the input (compounded ratio) increases, the effect on POBI increases (output). Indicated perceived POBI (ranges): these are the values typically resulting from the input and output values. In other words, this is the function's domain. These values were calculated by calibration.
◯	max feel fat	5	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
◯	normal feel fat, Male, Age 11	3.043	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
◯	normal feel fat, Male, Age 13	3.077	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses

Variable Type	Variable Name	Equation	Unit	Description
				based on the survey scales. This parameter is arrayed by gender and age group.
○	normal feel fat, Male, Age 15	2.999	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	normal feel fat, Female, Age 11	3.158	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	normal feel fat, Female, Age 13	3.278	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	normal feel fat, Female, Age 15	3.383	Dimensionless	This parameter indicates the average value defined by the HBSC survey responses based on the survey scales. This parameter is arrayed by gender and age group.
○	weight bias, Gender, Age Group	Social Norm on Body Image*(average body weight by gender & age group-average ideal weight)	kg	There is a social norm that dictates an ideal body weight, which is multiplied by a constant cultural parameter (that would change among countries). This calculation results on the difference between the current weight and the ideal weight called body bias. the distance between ideal weight and actual weight compounded for a cultural factor divided into current weight to normalize. This means how deviated is the representative individual from the ideal weight.

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