

# Systems thinking and body weight perception: Modelling interactions between the individual and the collective

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## Aim

To analyse the complex system that drives the social norms of obesity using system dynamics modelling.

## Methods

First, we developed a conceptual causal loop diagram (CLD) (Fig. 1), based on literature and on expert interviews, focusing on the social norms of obesity – a complex system of interactions between individual- and group-level body weight as well as socio-cultural elements such as individual and collective body weight perception.

## Background & scope

Inequalities in obesity prevalence may reflect diversity regarding the social norms of obesity that exist among different socio-cultural groups. Obesity prevalence shifts cause individuals to re-evaluate their body mass index (BMI) with reference to the average BMI in their socio-cultural group as opposed to a fixed standard. This is a social multiplier effect: the collective ideal BMI seems to be in flux as based on the average BMI within the socio-cultural group. Studying the link between the collective social norms of obesity and individual BMI may provide us with leverage points that work at the group-level rather than target the individual.

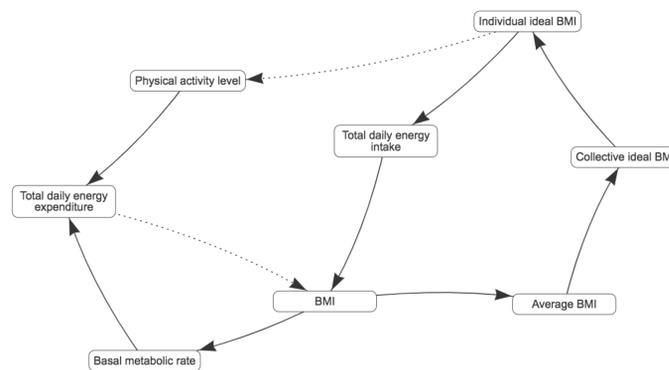


Fig. 1 Causal loop diagram.

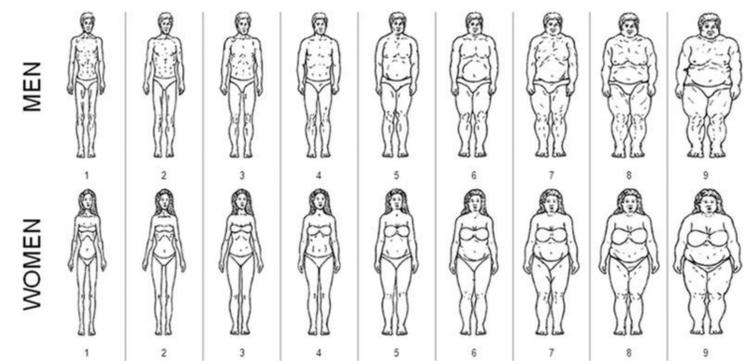


Fig. 2 Body image scale.

We then used system dynamics models (SDMs) that were based on this CLD to model the complex system that drives BMI in six different socio-cultural groups, which were defined based on a stratification by ethnicity and sex, as we expect the social norms of obesity to differ among these groups. The six SDMs model the dynamics of the social norms of obesity for Dutch men ( $n=753$ ), Moroccan men ( $n=774$ ), South-Asian Surinamese men ( $n=839$ ), Dutch women ( $n=848$ ), Moroccan women ( $n=1,086$ ) and South-Asian Surinamese women ( $n=999$ ) and will be initialised and fitted using the HELIUS data.

We will study the SDMs to see whether they mirror the hypothesised effects of the social norms of obesity on individual BMI and have the potential to simulate possible intervention scenarios.

Hereto, we will analyse the link between the social norms of obesity and individual BMI by embedding individual as well as collective ideal body weight perception variables which are obtained from the HELIUS data and based on a body image scale (Fig. 2) in these SDMs. We operationalised these variables by linking the BMI that was measured for each individual to silhouette drawings representing different body images (Fig. 2). The mean BMI of all individuals that selected a specific silhouette as their perceived BMI was taken to represent the BMI of that specific silhouette at the group level.

- **Perceived BMI:** individuals were asked to indicate which silhouette they most looked like right now.
- **Individual ideal BMI:** individuals were asked to indicate which silhouette they would prefer to look like.
- **Collective ideal BMI:** individuals were asked which silhouette they thought the men (for women) and women (for men) in their environment would find the most attractive, respectively.

## Discussion

The step to formulate a functioning SDM from a conceptual CLD is novel in the field of public health. In addition, this pilot study attempts to connect individual-level variables to collective socio-cultural environment processes as we believe that their interaction is vital in understanding the influence of the social norms of obesity on inequalities in obesity prevalence.

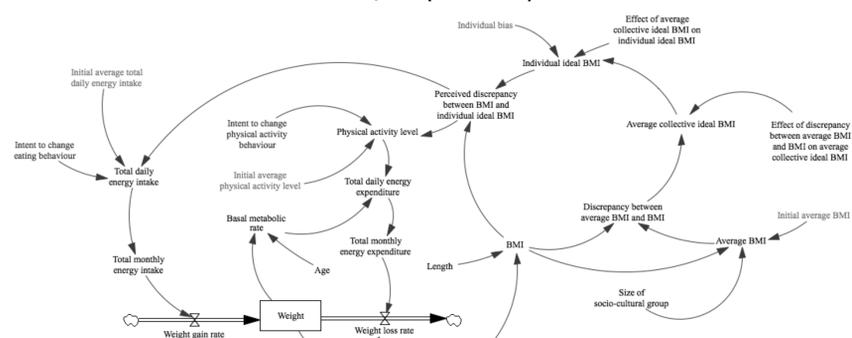


Fig. 3 System dynamics model.

Table 1 Characteristics of the study population at  $t=0$ .

	Men			Women		
	Dutch (n=753)	Moroccan (n=774)	South-Asian Surinamese (n=839)	Dutch (n=848)	Moroccan (n=1,086)	South-Asian Surinamese (n=999)
Age in years (mean ± SD)	48.52 ± 14.89	39.16 ± 11.88	43.96 ± 13.92	48.34 ± 14.74	34.13 ± 11.04	45.26 ± 12.75
PAL	1.6 (%)	27.49	44.96	41.12	24.41	58.38
	1.7 (%)	72.51	55.04	58.88	75.59	41.62
BMR in kcal (mean ± SD)	1794.04 ± 212.28	1815.18 ± 188.13	1732.21 ± 200.98	1418.84 ± 147.31	1442.04 ± 161.19	1386.09 ± 147.12
Total daily energy intake in kcal (mean ± SD)	2999.61 ± 356.74	3003.01 ± 314.11	2872.34 ± 334.81	2376.89 ± 249.56	2367.56 ± 277.33	2287.38 ± 245.22
BMI in kg/m <sup>2</sup> (mean ± SD)	26.00 ± 4.03	26.49 ± 4.06	25.82 ± 4.16	25.74 ± 5.09	26.73 ± 5.41	26.72 ± 5.23
Individual ideal BMI in kg/m <sup>2</sup> (mean ± SD)	24.61 ± 1.75	25.31 ± 1.61	24.50 ± 1.58	23.02 ± 2.32	23.70 ± 2.41	23.62 ± 2.26
Mean collective ideal BMI in kg/m <sup>2</sup>	24.65	25.40	24.66	22.94	23.77	23.55
Perceived discrepancy between BMI and individual BMI in kg/m <sup>2</sup>	< 0 (%) (underweight)	12.22	18.73	14.06	3.07	9.48
	= 0 (%) (satisfied)	38.78	34.63	34.21	31.60	24.95
	> 0 (%) (overweight)	49.00	46.64	51.73	65.33	65.56

## Results

The structure for the six SDMs was developed and is shown in Fig. 3. Based on this structure, six SDMs still need to be run using the HELIUS data for the different groups. Characteristics of the different socio-cultural groups, including values for individual as well as collective ideal body weight perception variables are presented in Table 1.